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The Engineer

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PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere road, Lambeth, S.E. 1, invites TENDERS for :—
1. STEEL SHEETS for FLOOR PLATES and PANELS.
2. STEEL GIRDER BRIDGE WORK.
3. W.I. TUBING for WATER and GAS.
Tenders due on the 23rd June, 1925, for No. 1, on the 25th June, 1925, for No. 2, and on the 30th June, 1925, for No. 3.
Tender forms obtainable from above. 9449

Applications are Invited by the Agent-General for Western Australia for the following POSITIONS in the Public Works Department of the Western Australian Government :—
HYDRAULIC ENGINEER.—Responsible (under the supervision of the Engineer-in-Chief) for the design, construction (departmentally), and maintenance of the principal works in the State appertaining to Water Supply, including Metropolitan Water Supply and Sewerage. Commencing salary £1020, rising to £1200.
HARBOUR ENGINEER.—Responsible (under the supervision of the Engineer-in-Chief) for the design, construction (departmental), and maintenance of the principal works in the State appertaining to Harbours and Rivers, including Wharves, Jetties, Breakwaters, Dredging and Reclamation, &c. Commencing salary £804, rising to £960.
Transport allowance £200 for married man, £100 for single man.
Should the successful applicants voluntarily relinquish their respective positions before the expiration of 2 years from the date of appointment, they will be called upon to refund the amount of transport allowance. Applicants should state age and whether married or single.
Applications should be endorsed "Hydraulic" or "Harbour" Engineer (as the case may be), and must reach the AGENT-GENERAL FOR WESTERN AUSTRALIA, Savoy House, 115, Strand, London, on or before the 29th June, 1925. 9444

Civil Engineer Required by the GOVERNMENT of KENYA COLONY for a tour of 20 to 30 months' service. Salary £400, rising by annual increments of £20 to £500 a year, and thence by annual increments of £25 to £600 a year. Free single quarters or an allowance in lieu. Free passages and liberal leave on full salary. Outfit allowance of £30 on first appointment. Candidates, aged 25-35, must have passed examination to qualify for A.M.I.C.E. or hold equivalent professional qualifications. Must have had not less than two years' experience, either as a pupil or assistant on the design and construction of waterworks.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/13,493. 9410

Civil Engineers (2) Required by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT for a tour of from 12 to 18 months' service. Free passages and quarters and liberal leave on full salary. Outfit allowance of £60 on first appointment. Salary £480 for the first three years of service and then £510, rising to £720 by annual increments of £30, and thence rising to £920 by annual increments of £40. Candidates, aged 25-35, preferably Associate Members of the Institution of Civil Engineers, should be good surveyors and have had considerable experience in practical town planning and be conversant with Ministry of Health procedure on town planning.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/13,510. 9474

Senior Waterworks Engineer REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of 12 to 18 months' service in the first instance. Subject to satisfactory service the officer appointed will be eligible at the expiration of 3 years' service in the post for confirmation in the permanent and pensionable establishment. Salary £960 a year, plus a duty allowance of £96 a year. Free passages and quarters and liberal leave on full salary. Candidates, not over 45 years of age, must be Corporate Members of the Institution of Civil Engineers or hold equivalent professional qualifications, possess a thorough knowledge of and experience in the design and construction of Waterworks, and have had special experience of the investigation of water supplies in the tropics or elsewhere.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/13,684. 9475

Municipal Technical School, SWANSEA.
PRINCIPAL: T. GILBERT JONES, M.Sc., Wh.Sch., A.M.I.E.E., A.M.I.C.E.
LECTURESHIP IN ELECTRICAL ENGINEERING.
APPLICATIONS are INVITED for the POSITION of LECTURER in ELECTRICAL ENGINEERING. Applicants must possess a University Degree or its equivalent and have had works experience. Teaching experience desirable. Salary according to Burnham Technical Scale. Forms of application and conditions of appointment may be obtained from the undersigned, by whom applications, accompanied by copies of recent testimonials, must be received not later than first post on Wednesday, the 24th June.
T. J. REES,
Director of Education.
Education Office,
Dynevor-place, Swansea,
9th June, 1925. 9440

University of the Witwatersrand, JOHANNESBURG.
CHAIR OF ELECTROTECHNICS.
APPLICATIONS are INVITED for the CHAIR of ELECTROTECHNICS, vacant through the retirement, under superannuation, of Professor H. J. S. Heather.
SALARY.—£1000 per annum, rising by annual increments of £50 to £1100.
TRANSPORT.—Allowance of £60 towards passage expenses, together with free first-class ticket from Cape Town to Johannesburg. Half salary during voyage.
CONDITIONS.—The appointment is full-time, and subject to the regulations of the University. Duty to be assumed in January, 1926.
Applications, with copies of testimonials, all in quintuplicate, should be lodged with the SECRETARY, Office of the High Commissioner for the Union of South Africa, Trafalgar-square, W.C. 2 (from whom further particulars and forms of application may be obtained), not later than 25th June, 1925. 9398

PUBLIC NOTICES

Bombay, Baroda and Central India Railway Company.
The Directors are prepared to receive up to 2.30 p.m. on Wednesday, 24th June, TENDERS for the SUPPLY of :—
1. METALS.
2. STEEL MATERIAL (ANGLES, PLATES, &c.).
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices : 91, Petty France, Westminster, S.W. 1,
8th June, 1925. 9429

Borough of Maidstone.
WIDENING OF MAIDSTONE BRIDGE OVER THE RIVER MEDWAY.
The above Authority is prepared to receive TENDERS from responsible contractors who have been extensively engaged in Bridge Construction for the WIDENING of the above-mentioned BRIDGE.
Applications for bills of quantities and forms of Tender to be made in the first case to Mr. T. F. Bunting, Borough Surveyor, Fairmeadow, Maidstone, by June 23rd, 1925.
The applicants will be notified later when the above particulars are ready and will receive same on payment of Five Guineas, which will be refunded on receipt of a bona fide Tender.
The Council do not bind themselves to accept the lowest or any Tender.
S. LANCE MONCKTON,
Town Clerk.
72, King-street, Maidstone,
June 6th, 1925. 9417

The Assam-Bengal Railway COMPANY, Limited, is prepared to receive TENDERS for :—
STEEL TYRES for CARRIAGES and WAGONS.
Specifications and Tender forms may be obtained at the Offices of the Company, Bishopsgate House, 80, Bishopsgate, E.C. 2. A fee of £1 1s. is charged, which cannot under any circumstances be returned.
Drawings may be had at the cost of the tenderer, by application to Messrs. Hodges, Bennett and Co., Ltd., 78, Queen Victoria-street, E.C. 4.
Tenders must be delivered at the Company's offices not later than Noon on Wednesday, the 24th June, 1925.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
OSWALD I. MILNE,
Secretary.
8th June, 1925. 9443

The Bengal and North-Western Railway Company, Limited.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
310 TONS STEEL MATERIAL,
98 TONS WROUGHT IRON,
as per specifications to be seen at the Company's offices.
Tenders, addressed to the undersigned, and marked "Tender for Steel Material," or as the case may be, with name of firm tendering, to be lodged not later than Noon on the 23rd day of June, 1925.
For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
E. A. NEVILLE,
Managing Director.
237, Gresham House, Old Broad-street,
London, E.C. 2, 8th June, 1925. 9414

PUBLIC NOTICES

City and County of Norwich.
THORPE POWER STATION.
The Norwich Corporation invite TENDERS for the MANUFACTURE, DELIVERY and ERECTION of the undermentioned ENGINEERING WORKS in connection with the above Power Station, viz :—
STEAM, WATER and other PIPE WORK, VALVES, TANKS, &c., &c.
Specifications, drawings and forms of Tender may be obtained from Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, Westminster, S.W. 1, on payment of a deposit of £5, which will be refunded on receipt of a bona fide Tender, within the prescribed time.
Two copies of the specification and form of Tender will be supplied to each applicant. Extra copies may be obtained on payment of Ten Shillings for each copy, which will not be returnable.
Sealed Tenders, endorsed "Thorpe Power Station, Tender for Pipe Work, &c.," must be delivered to me at my office not later than 10 a.m. on Friday, 3rd July, 1925.
The lowest or any Tender will not necessarily be accepted, and the Corporation will not consider any Tender which is incomplete, or which does not include the whole of the work covered by the specification.
ARNOLD H. MILLER,
Town Clerk.
Guildhall, Norwich,
8th June, 1925. 9419

County Borough of Brighton.
WATERWORKS DEPARTMENT.
TO PIPE FOUNDERS.
The Waterworks Committee invite TENDERS for the SUPPLY of about 360 TONS of 16in. diameter, Class "C," 240 TONS of 18in. diameter, Class "B," and about 320 TONS of 18in. diameter, Class "C" CAST IRON PIPES to the British Standard Specification, together with SPECIALS of both diameters, delivered in Brighton.
Specification and form of Tender may be obtained from the Waterworks Engineer, Mr. A. B. Cathcart, M. Inst. C.E., 12, Bond-street, Brighton, upon payment of a deposit of Two Guineas, which will be refunded upon receipt of a bona fide Tender not subsequently withdrawn.
Sealed Tenders, endorsed "Tender for C.I. Pipes," to be delivered at my office, Town Hall, Brighton, not later than Noon on Monday, July 6th, 1925.
The Committee do not bind themselves to accept the lowest or any Tender.
JAS. H. ROTHWELL,
Town Clerk.
Town Hall, Brighton,
10th June, 1925. 9451

County Borough of Brighton.
WATERWORKS DEPARTMENT.
TO MAIN-LAYING CONTRACTORS.
The Waterworks Committee are prepared to receive TENDERS from responsible contractors for LAYING about 2520 YARDS of 18in. and about 1780 YARDS of 16in. CAST IRON MAINS in Ditchling-road, Hollingbury-road, Hollingdean-road, Old-lane, and Surrenden-road, Brighton.
Specification, quantities, and form of Tender may be obtained and drawings inspected on application to Mr. A. B. Cathcart, M. Inst. C.E., Waterworks Engineer, 12, Bond-street, Brighton, on payment of a deposit of Three Guineas, which will be refunded upon receipt of a bona fide Tender not subsequently withdrawn and the return of all documents.
Sealed Tenders, endorsed "Tender for Laying 18in. and 16in. Water Mains," to be delivered at my office, Town Hall, Brighton, not later than Noon on Monday, July 6th, 1925.
The lowest or any Tender will not necessarily be accepted, and Tenders will only be considered from responsible contractors having the necessary experience.
JAS. H. ROTHWELL,
Town Clerk.
Town Hall, Brighton,
10th June, 1925. 9450

PUBLIC NOTICES

The South Indian Railway Company, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
1. R.S. DISC WHEELS and AXLES.
2. SOLID-DRAWN STEEL BOILER TUBES (1).
3. STEEL FISH-PLATES.
4. TIE BARS, GIBS and COTTERS.
5. CAST IRON POT SLEEPERS.
6. FISH BOLTS, NUTS and WASHERS.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Wheels and Axles," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 26th June, 1925.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 10s. for each copy of Specifications Nos. 1, 2, 3 and 4; of £1 for each copy of Specification No. 5; and of 5s. for each copy of Specification No. 6.
Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, of 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France,
Westminster, S.W. 1,
9th June, 1925. 9455

PUBLIC HEALTH ACT, 1875.
Urban District Council of Letchworth, Hertfordshire.
LETCHWORTH MAIN DRAINAGE.
CONTRACT NO. 3.
The Urban District Council of Letchworth, acting as the Sanitary Authority for the said District, are prepared to receive TENDERS for the SUPPLY of CIRCULAR SEWAGE DISTRIBUTORS.
Particulars and specifications may be obtained at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, 28, Victoria-street, Westminster, on and from Monday, the 22nd of June, until Wednesday, the 1st of July, between the hours of 10 a.m. and 4 p.m., upon payment of a deposit of One Guinea, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.
The successful tenderer will be required to execute a contract deed, the draft of which may be seen at the offices of the Consulting Engineers when the drawings are inspected.
Tenders must be on the official form, each Tender in a sealed envelope, marked "Tender for Sewage Distributors," Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers.
Each Tender must be signed in the handwriting of the tenderer or his authorised agent.
The Council does not bind itself to accept the lowest or any Tender.
Tenders must reach the undersigned by 9 a.m. on Monday, the 13th of July, 1925.
Given under my hand the 9th day of June, 1925.
GEORGE BROWN,
Clerk to the Letchworth U.D.C.
Council Offices,
Broadway Chambers,
Letchworth, Herts. 9433

PUBLIC HEALTH ACT, 1875.
Urban District of Greenford, MIDDLESEX.
The Urban District Council of Greenford, acting as the Sanitary Authority for the said District, are prepared to receive TENDERS for the EXTENSION of the MAIN DRAINAGE SYSTEM (Contract No. 8).
Particulars and specification may be obtained at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, 28, Victoria-street, Westminster, on and from Tuesday, the 16th of June, until Saturday, the 27th of June, between the hours of 10 a.m. and 4 p.m., upon payment of a deposit of Two Guineas, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.
The successful tenderer will be required to execute a contract deed, the draft of which may be seen at the offices of the Consulting Engineers when the drawings are inspected.
Tenders must be on the official form, each Tender in a sealed envelope, marked "Tender for Main Drainage Extension." Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers.
Each Tender must be signed in the handwriting of the tenderer or his authorised agent.
The Council does not bind itself to accept the lowest or any Tender.
Tenders must reach the undersigned by 9 a.m. on Monday, the 6th of July, 1925.
Given under my hand the 4th day of June, 1925.
A. LLOYD JONES,
Clerk to the Council.
New Broadway Chambers,
New Broadway, Ealing, W. 5. 9396

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PUBLIC NOTICES

Metropolitan Water Board.

HONOR OAK RESERVOIR SUPPLY MAINS.
TENDER FOR THE LAYING AND JOINTING OF 42in., 27in., AND 15in. DIAMETER CAST IRON MAINS FROM HOMESTALL-ROAD, CAMBERWELL, TO QUEEN'S-ROAD, PECKHAM.

The Metropolitan Water Board invite TENDERS for the LAYING of 42in., 27in., and 15in. internal diameter WATER MAINS from Homestall-road, Camberwell, to Queen's-road, Peckham, together with CONTINGENT WORKS.

Drawings, conditions of contract and specification may be inspected without payment of a fee at the offices of the Board, Chief Engineer's Department (Room 201), on and after 16th June.

Form of Tender, conditions of contract and specification, bills of quantities, schedules of prices, together with drawings and a spare copy of the bills of quantities and schedules of prices, may be obtained on and after 16th June from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on the production of an official receipt for the sum of £10, which sum must be deposited with the Accountant to the Board at 173, Rosebery-avenue, Clerkenwell, E.C. 1, and will be returned on receipt of a bona fide Tender, accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities and schedules of prices, which may be retained by the tenderer).

Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon).

Cheques must be made payable to "The Metropolitan Water Board" and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, Clerkenwell, E.C. 1," and endorsed "Tender for Honor Oak Reservoir Supply Mains," must be delivered at the offices of the Board not later than 10 a.m. on Tuesday, 7th July, 1925.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue,
Clerkenwell, E.C. 1. 9471

PUBLIC HEALTH ACT, 1875.

Rural District of St. Albans,

HERTFORDSHIRE.
LONDON COLNEY MAIN DRAINAGE.
CONTRACT NO. 3.

The Rural District Council of St. Albans, acting as the Sanitary Authority for the said District, are prepared to receive TENDERS for the SUPPLY of CIRCULAR SEWAGE DISTRIBUTORS.

Particulars and specification may be obtained at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, 28, Victoria-street, Westminster, on and from Monday, the 22nd of June, until Wednesday, the 1st of July, between the hours of 10 a.m. and 4 p.m., upon payment of a deposit of One Guinea, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.

The successful tenderer will be required to execute a contract deed, the draft of which may be seen at the offices of the Consulting Engineers when the drawings are inspected.

Tenders must be on the official form, each Tender in a sealed envelope, marked "Tender for Sewage Distributors." Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers.

Each Tender must be signed in the handwriting of the tenderer or his authorised agent.

The Council does not bind itself to accept the lowest or any Tender.

Tenders must reach the undersigned by 9 a.m. on Monday, the 13th of July, 1925.

Given under my hand the 9th day of June, 1925.

E. F. W. HEATT.
Clerk to the St. Albans R.D.C.

Union Offices, St. Albans. 9434

Jodhpur Railway.

ASSISTANT CIVIL ENGINEER.

An ASSISTANT ENGINEER, who must have had at least three years' practical experience either with a Railway Company or with a Public Works Contractor, is REQUIRED for employment on the permanent staff of the above Railway.

Applicants must have received a good general education, preferably at a public school, and have obtained an engineering degree at a recognised engineering college, or have passed the Associate Membership Examination of the Institution of Civil Engineers. They should be between 25 and 30 years of age and unmarried.

SALARY.—Commencing at Rs. 675 per calendar month, with increases according to the rules in force, with a three years' agreement in the first instance, first-class free passage to India and home again on satisfactory termination of services.

Applications, giving full details of candidates' career, in chronological order (with dates), and giving names of railway companies or firms by whom they have been employed from time to time, together with copies only of testimonials, must be received by the undersigned not later than the 3rd July, 1925.

RENDEL, PALMER AND TRITTON.
(Appointments Dept.),
12-14, Dartmouth-street,
Westminster, S.W. 1. 9472

The Trustees of the Port and

HARBOURS of GREENOCK REQUIRE the ADVISORY SERVICES of a CONSULTING ENGINEER with large experience in Dock, Graving Dock, Mechanical Reinforced Concrete, Steel Works, &c.

Apply, giving full particulars experience and retaining fee required, to J. McLELLAN, Clerk to the Trustees. Envelope to be marked "Consulting Engineer." 9476

Warwickshire County Council.

TEMPORARY ENGINEERING ASSISTANT.

APPLICATIONS are INVITED for the above APPOINTMENT at a salary at the rate of £400 per annum.

Candidates must have a thorough knowledge of the design and construction of Reinforced Concrete Work, including Bridges.

The appointment will probably be for a period of at least 12 months.

Applications, stating age, qualifications, and when able to commence duties, together with copies of two recent testimonials, must be delivered to the undersigned as soon as possible, but not later than the 22nd instant.

D. H. BROWN,
County Surveyor.

County Surveyor's Office,
8, Northgate-street, Warwick,
10th June, 1925. 9460

SITUATIONS OPEN

WANTED, a YOUNG MAN, 30 to 35 Years of Age, to Assist in General Management of Large High-class Machine Tool Works. Must have had shop, drawing-office and commercial experience in the trade. Knowledge of French desirable. Good opportunity for suitable man. Give full particulars of experience, copies of testimonials, age, and salary.—Address, 9418, The Engineer Office. 9418 A

WANTED, Experienced COMMERCIAL ENGINEER, to REPRESENT a BRITISH FIRM who specialise in High-pressure Steam and Water Pipe Installations. Salary £1000 per annum and commission. Only men with excellent connection and sound knowledge of export trade need apply. All applications will be treated in strictest confidence.—Address, 9441, The Engineer Office. 9441 A

WANTED, WORKS MANAGER for Mechanical Engineering Company employing 400-500 hands and producing a highly specialised product, medium heavy type of engineering. Must have thorough knowledge of machining and latest practice and experience of modern machine tools. Able to organise (no use for elaborate recording systems). Must have plenty of push and not afraid of hard work. Age 35-45. State experience, salary required, and when at liberty.—Address, 9437, The Engineer Office. 9437 A

SITUATIONS OPEN (continued)

WANTED, Young ENGINEER, to Take Charge of Steam Generating Plant and with view to filling position of Assistant Engineer. Must be fully trained, good draughtsman, and not afraid of work.—Address, stating age and nationality, 9448, The Engineer Office. 9448 A

CIVIL ENGINEERING ASSISTANT.—WANTED AT ONCE, competent ENGINEERING ASSISTANT; large experience modern Sewerage and Sewage Disposal and Water Supply Works.—Address particulars, 9357, The Engineer Office. 9357 A

LONDON REPRESENTATIVE, Whole Time, WANTED by makers of Petrol and Paraffin Engines, marine and stationary. State age, salary, and references in confidence.—Address, 9442, The Engineer Office. 9442 A

PERMANENT WAY INSPECTOR, for Turkey, with thorough knowledge of Track with Flat-footed Rails on Wood and Steel Sleepers. Age 30 to 40 years, preferably single. Must be tactful, temperate and healthy. His duties will be to instruct gangs in all details of track work and will involve constant travelling. Duration of appointment two years.—Further particulars on application by letter to Box 1048, c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 9392 A

PRACTICAL INSPECTOR REQUIRED IMMEDIATELY for Construction of Wood Pole and Steel Tower Transmission Lines. Previous experience essential. State experience, age, salary required.—Address, P720, The Engineer Office. P720 A

REQUIRED, STEEL TRAVELLER, with First-class connection amongst buyers and actual users within radius of 25 miles City of London, by old-established British Manufacturers of High-grade Steels and Tools.—Address in first instant, 9423, The Engineer Office. 9423 A

REINFORCED CONCRETE ENGINEERS and CONTRACTORS have VACANCY for JUNIOR ENGINEER. Candidates must have a good engineering degree, and preferably at least a year's practical experience in the design of Reinforced Concrete Structures.—Written applications, with full particulars of training and experience, and stating age and salary required, to K. HOLST and CO., 1, Victoria-street, S.W. 1 9461 A

TEMPLATE MAKER WANTED for Bombay, Used to Bridge and Constructional Work.—Apply, stating age, experience, and salary required, to GENERAL MANAGER, Braithwaite and Co., Engineers, Ltd., West Bromwich. 9452 A

TWO REINFORCED CONCRETE DESIGNERS with specialist experience REQUIRED by a leading provincial firm.—Applications, giving a summary of experience, age, and salary required, to be addressed in the first instance to 9436, The Engineer Office. 9436 A

WANTED, DRAUGHTSMAN, by Well-known Firm of Milling Engineers.—Address, stating experience, &c., 9285, The Engineer Office. 9285 A

WANTED, DRAUGHTSMAN, Constructional, thoroughly experienced in design and working details for Steel-frame Buildings.—Apply by letter, stating age and salary required, to BANISTER, WALTON and COMPANY, Limited, Trafford Park, Manchester. 9439 A

WANTED, DRAUGHTSMAN, with Experience of Hydraulic Work, including Cranes and Hoists. Applications must state experience, age, and salary required.—Apply by letter only to the HYDRAULIC ENGINEERING CO., Ltd., Chester. 9431 A

WANTED, Experienced DRAUGHTSMAN (not less than 5 years' experience) in designing Heating, Hot Water Supply, Ventilation, and large Centralised Plants.—Address fully, giving age and salary required, 9402, The Engineer Office. 9402 A

WANTED, First-class DRAUGHTSMAN, Fully conversant with all kinds of Baling Presses. Must be capable of fixing sizes, pressures, &c., for all usual substances baled.—Address, 9433, The Engineer Office. 9433 A

WANTED, MECHANICAL DRAUGHTSMAN, with experience of Rotary Newspaper Machinery.—Address, stating age, experience, and salary required, P699, The Engineer Office. P699 A

WANTED, SENIOR DRAUGHTSMAN, Fully experienced and accustomed to the designing of Printing and High-speed Automatic Machinery.—Apply by letter only, giving full particulars as to experience, references, salary required, &c., JOB DAY and SONS, Ltd., Beeston Royds Works, Leeds. 9403 A

CHIEF DRAUGHTSMAN of Proved Organising capacity REQUIRED for Drawing-office Staff of about 20 men by firm of Steam Engineers and Steam Wagon Makers in Midlands.—Address, 9405, The Engineer Office. 9405 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, 84, George's-square, London, S.W. 1. 8768 A

DRAUGHTSMAN (Constructional) WANTED, Westminster district. Temporary, possibly permanent. State qualifications, age, salary required.—Address, 9473, The Engineer Office. 9473 A

DRAUGHTSMAN REQUIRED, Experienced in Rotary Printing Press Work.—Address full particulars of experience and salary required, 9395, The Engineer Office. 9395 A

DRAUGHTSMAN REQUIRED (Sugar Machinery), England.—Address, 9430, The Engineer Office. 9430 A

DRAUGHTSMAN REQUIRED, with Wide Experience of High-speed Engines and Condensing Machinery, as well as Lay-out of Central Station Plants. Only first-class men need apply.—Write, giving full particulars, with age and salary required, to W. H. ALLEN SONS and CO., Ltd., Bedford. 9407 A

DRAUGHTSMAN WANTED for Calcutta, Used to Bridge and Constructional Work, the Design of Structures, also Quantities and Estimates.—Apply, stating age, particulars of experience, and salary required, to GENERAL MANAGERS, Braithwaite and Co., Engineers, Ltd., West Bromwich. 9453 A

DRAUGHTSMAN WANTED for Design of Steam Engines and Pumping Machinery. Must have up-to-date experience in this class of work. For right man this is a good opening. State age, experience, and salary required.—Address, 9459, The Engineer Office. 9459 A

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SOUTH AMERICA.—CIVIL and ELECTRICAL ENGINEER (35), A.M.I.C.E., A.R.T.C., A.I. Mech. E., experience in design and construction of harbours, bridges, roads, steel work and reinforced concrete, water supply, sewage and drainage, hydro-electric and steam power stations, power distribution, can speak French, German, Portuguese, present location São Paulo, Brazil, engagement expiring soon, WISHES to NEGOTIATE for a NEW APPOINTMENT.—Address, 9447, The Engineer Office. 9447 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Wages and Hours in the Engineering Industry.

FOLLOWING the rejection on May 20th of the proposals made by the Engineering Employers' Federation to the engineering unions regarding wages and hours in the industry, the employers on June 2nd submitted a reply, in which it was suggested that the unions might possibly be misinterpreting the intention of the proposals. The employers urged that their proposals were not intended to be taken in the nature of a reply to the men's demand for an all-round wages increase of 20s. a week, but as providing a basis for a mutual effort to revivify the industry and create employment. The situation of the industry, it was added, had now become extremely grave, and the unions' representatives were requested to apply their minds to the situation with much greater precision than the terms of the rejection resolution disclosed. Speaking at Hull on Sunday, the 7th, Mr. J. T. Brownlie, president of the Amalgamated Engineering Union, gave little or no sign that the employers' request for "greater precision" would be met. If, he said, the employers attempted to enforce an extension of working hours in the engineering industry they would create one of the most serious issues the nation had been called upon to face since the war. The contingency would not be good either for the workpeople, the industry, or the nation. The employers' letter of the 2nd was, however, to be considered at a meeting on the 19th, and it was hoped that at a farther meeting they would succeed in persuading the employers not to put into force the proposal for an extension of the working week. Mr. Brownlie added that he thought the unions would be successful in their persuasion, but it was just possible that the forces against them might be too formidable, and that they would be driven to take "an extraordinary step."

Scapa Flow Salvage Operations.

FURTHER interest is lent to the task of salving the scuttled German Fleet at Scapa Flow, by the announcement that the firm of Cox and Danks, Ltd., of 168, Regent-street, London, has purchased from the Admiralty the sister floating dock to that which, after reconditioning and enlargement, was recently towed to Malta. The dock, which has been lying at Chatham for some time, comprises six sections, and has an approximate length of 700ft. and a lifting capacity of 40,000 tons. The main section will be towed by Cox and Danks to Scapa Flow, where it will most likely play an important part in the scheme for raising the large battleships. This task will only be begun, however, when the present programme covering the destroyers has been more or less completed. It is hoped to finish raising the destroyers before the winter weather sets in. The twelfth destroyer, which was lying on its side, was raised in the afternoon of June 5th, and was beached at Mill Bay within four days of the lifting pontoons moving out to sea. The remaining sections of the large dock just purchased will, we learn, be broken up at the firm's shipbreaking department at Queenborough, Kent, where the work on the demolition of the two 25,000-ton Dreadnoughts Erin and Orion, which were scrapped under the terms of the Washington Agreement, has just been finished.

The Late Mr. James Hunter Gray.

THE British Patent Bar is sensibly the poorer by the death of Mr. James Hunter Gray, K.C., which occurred last week in a nursing home in London, following an operation. Mr. Gray was an engineer and a scientist before he became an advocate, having studied under Lord Kelvin at Glasgow University, and taken a distinguished degree. His excellent training had, undoubtedly, much to do with his success in his profession, but he was, in addition, possessed of much forensic skill, and was endowed to a marked degree with the gift of clear expression, and with the rare ability of making the most intricate technical processes and machinery appear simple to the lay mind. He had been engaged in practically all the most important patent actions of the last quarter of a century, and ably represented the Government in the inquiries into the applications for compensation to inventors for inventions made use of during the war. His disappearance from the Law Courts will be deeply felt by a wide circle of friends.

A Clyde Engine Works to Close Down.

IT is with considerable regret that we learn of the decision of the directors of the North British Diesel Engine Works (1922), Ltd., to close down temporarily the company's Whiteinch works to-morrow—Saturday—the 13th inst. When in full work this well-planned factory, which was specially equipped for the manufacture of marine oil engines employed about 1200 men. During the recent depression work could only be found for some 120 workmen, in addition to the permanent staff, and now that all contracts have been completed and no further orders are at present in sight, the works are to be closed and only a nucleus staff retained. The North British Diesel Engine Works (1922), Ltd., is associated with the Swan, Hunter and Wigham Richardson group of firms with which Barclay, Curle and Co., Ltd., are also prominently identified. The last ship to be completed and engined at Whiteinch was No. 608, which was launched by Barclay, Curle, on March 31st, and is now awaiting her trials. Notable ships engined by the North British Works and fitted with the firm's own design of four-cycle machinery were the Domala in 1921; the Dumra, Durenda, Dwarka and Hauraki in 1922; and the Dumana in 1923. Last year the Swanley was fitted with a 2000 brake horse-power double-acting sliding cylinder engine, which was described in our issues of April 23rd and May 2nd, 1924. The same type of machinery was installed in the ship No. 608 recently completed. It is to be hoped that new orders will allow this well-equipped oil engine works to resume activity at no distant date.

The Performance of Aeroplanes.

IN the course of a lecture on Tuesday on "Imperial Air Routes to India and Australia," before the Royal Colonial Institute, Air Vice-Marshal Sir Sefton Brancker, the Controller of Civil Aviation, gave some interesting particulars of aeroplane performance to-day as compared with that of the war and immediately post-war periods. During the war, he said, our best machines only flew for about 250 hours between overhauls. To-day cross-Channel aircraft were flying for 1500 to 2000 hours without overhaul. In 1919 the cost of air transport was taken at 10s. per ton-mile. To-day the latest costs worked out at about 4s. 6d. per ton-mile at a speed of 95 miles an hour. With a 60 per cent. load the cost came to about 8d. a mile per passenger with 40 lb. of luggage. For the transport of goods Imperial Airways was now charging about 2d. a pound per hundred miles. It had taken five years to live down the wartime reputation of aviation for costliness and peril, but he believed that the great air age was now beginning. Within the next two or three years, he prophesied, we would have airships running regularly to India and thence to Australia, and aeroplanes flying on schedule to the East *viâ* Baghdad.

The French Navy.

THE failure to include battle-cruisers in the programme of naval construction now being carried out in France is regarded by most French naval experts as a serious mistake, and what appear to be convincing arguments are being brought forward to show the necessity of completing the programme by the addition of a certain number of capital ships. Until recently, the principle of providing for defence exclusively by means of small and fast cruisers, torpedo-boats and seaplanes, in conjunction with the military air service, was regarded as the only one which could be safely followed by a country with a limited naval budget. Battleships were looked upon as vulnerable to the smaller craft, and particularly to aeroplanes. It was supposed that their provision would come up for academic discussion during the latter term of the period covered by the programme, when the laying down of such ships would depend upon the experience gained with them in other countries. It is now seen that experience already secured is sufficient to warrant serious attention being given to capital ships without waiting until other countries have taken too great a lead. The vulnerability of capital ships to air attack is found to be more open to question than had been assumed. French experts are therefore becoming increasingly insistent in their demands for capital ships now that they have some practical data with which to back up their arguments. The manner in which they are urging the necessity of these additions to the fleet suggests that the construction of a certain number of battle-cruisers will eventually come up for discussion, unless, of course, the situation should be regarded as modified by the proposed pact for mutual defence.

Fixed Stars.

THE faith exhibited by astronomers in their instruments and measurements frequently astonishes us. We have long since succeeded in ridding our minds of the belief so sedulously taught at one time in the fixity of the stars. We took the matter on trust. Not until we turned over the Astronomer-Royal's report presented to the Board of Visitors on June 6th did we realise on what shadowy grounds our trust reposed. In a certain zone of the sky, described as that lying between declinations 64 deg. and 66 deg., 18,194 stars have been catalogued. At Greenwich Observatory the examination of this zone for proper motion among its stars was completed during the year under review. The method of examination consisted of comparing photographs taken now with some taken twenty-five to thirty years ago. It was found that fifty-four stars had proper motions in excess of 20 seconds of angle per century, that fifty-seven stars had a proper motion of between 15 and 20 seconds in a like period, that fifty-seven stars had a proper motion of 10 to 15 seconds, and that 978 had a proper motion of 5 to 10 seconds. To detect an actual displacement equivalent to 1 to 5 seconds of angle on a photographic plate must be a feat of no mean ability. But when we reflect that the accuracy of the determination presupposes—or so we take it—that the camera lens, even though it were the same as was used a quarter of a century ago, suffered no unequally distributed change in its optical properties, and that the gelatine films of the photographic plates were entirely guiltless of unequal contraction, we begin to suspect that faith as well as ability went to the making of the observations. In any event, the real lesson seems to be not that motion was detected in 1263 stars, but that no motion was discovered in 16,931. For every star in which motion is said to exist, there are over thirteen in which no motion has been observed. Surely in light of that disproportion, those of us who may wish to continue a belief in the fixity of the stars may find ample ground for argument.

The New Graving Dock at Durban.

TOWARDS the end of last week the Prince of Wales formally opened and named the new graving dock which has been constructed by the South African Railways and Harbours Department at the Port of Durban (Natal). The work, which has taken over five years to complete, was carried out under the direction of Mr. W. R. Crabtree, M. Inst. C.E. In an article published in our issue of October 3rd last year we gave some particulars of the dock and its machinery. The dimensions are such as to place it among the three largest graving docks in the world, the other two being at Quebec and Vancouver, B.C., respectively. The dock has an overall length of 1150ft. and is 110ft. wide at the entrance and 138ft. at the coping. The depth of water on the sill is 41ft. at H.W.O.S.T. and 35ft. at L.W.O.S.T., and the amount of water required to fill it is over 38,000,000 gallons. Two caissons divide the dock into two compartments approximately 440ft. and 660ft. in length, and by placing the outer caisson in an emergency stop the length of the dock can be increased to 1191ft. In naming the dock after himself the Prince of Wales made reference to the importance of this completed work for the shipping trade of South Africa, and for the vessels of all maritime countries which visit the shores of the Dominion. From the dimensions we have given it will be appreciated that the new dock can comfortably accommodate the largest vessels afloat, since the White Star liner, the Majestic, the largest liner in the world, has only a length a little over 956ft. and a beam of 100ft., with a displacement of about 64,000 tons.

Gas versus Electricity.

ON this page in our issue of May 29th we summarised the arguments and criticisms of the gas industry against the Government's various proposals for encouraging the supply of electricity. On Tuesday the matter was carried a step further when the Minister of Transport received a deputation, introduced by Mr. Milne Watson, representative of practically the whole of the company and municipal gas undertakings in the country. Mr. Milne Watson and other speakers referred to the uncertainty which prevailed in the gas industry at the present time by reason of lack of knowledge concerning the Government's proposals with regard to electrical development. The views of the gas industry were stated at some length by various speakers, and the Minister was asked to indicate as soon as possible the proposals affecting in any way the gas and the electrical industries which the Government would consider. Colonel Ashley, in replying, stated that it was impossible for him at present to state what the Government's proposals might be, but he undertook to bear in mind the representations which had been made to him and to see that due consideration was given to them. He would, he added, be glad at any time to receive representations on the subject from those interested in it. The same subject was referred to by Mr. J. Ferguson Bell in his presidential address which he delivered to the Institution of Gas Engineers on Tuesday, and which we reprint in abstract elsewhere in this issue.

Aircraft and Ships.

SIR ALFRED YARROW, like Sir Sefton Brancker, is clearly of the opinion that the age of aerial travel is approaching. Speaking on his return from a two months' trip up the west coast of North America and across Canada, he expressed the opinion that in twenty years' time or sooner high-speed passenger traffic across the Atlantic would be conducted by aircraft, with the result that steamships of the excessive speed now demanded would no longer be required. He suggested that in the days to come vessels of the size of the Mauretania, driven at 19 to 20 knots by means of oil engines or steam turbines, combined with water-tube boilers, would be adequate to secure what would be needed. Vessels of this size but with half the power of the Mauretania could, he said, be run economically, and the great saving in the weight of engines, boilers and fuel would permit of a largely increased cargo or passenger carrying capacity. Dealing with the development of the airship, he visualised the construction of vessels to fly at great heights, the cabins being enclosed, and the normal air pressure retained in them by artificial means. Such a scheme applied to aeroplanes was, it may be recalled, worked out in detail some few years ago by Professor Rateau, of Paris.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XXIV.*

PERIOD 1866 TO 1869 (*continued*).

DETAILS.

DURING this period (in 1868, according to W. P. Marshall) frame plates were supplied in one piece from the rolling mills, after which welded frames disappeared. Adams's method of attaching the cylinders and also his sliding bogie have already been mentioned.

Boilers.—The fire-box with direct roof stays in place of girders made its appearance in W. Bouch's Stockton and Darlington engines, but it is by no means certain that these were the first engines in this country to have this method of staying. It had previously been employed in Belgium and France, and direct stays in combination with roof girders had been used in America. According to the late Edward Reynolds direct stays had been used in some of the earliest Great Northern engines, the date of which was not given.

In 1866 Dudgeon's tube expander, an American invention, was introduced into this country. The tubes were secured by a shoulder and the end beaded over by the same tool. It was first tried on the North London Railway by W. Adams, to whom Zerah Colburn gave a sample.

Motion, &c.—Early in 1866 Ramsbottom applied

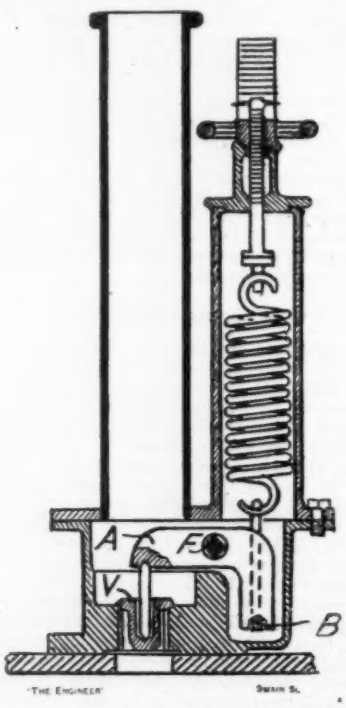


FIG. 187—NAYLOR'S SAFETY VALVE

bush ends to the coupling rods of the 2–4–0 engines previously described. This simplification, which dispensed with brasses and cotters, was almost immediately taken up by most locomotive engineers, largely to avoid the trouble caused by drivers who persisted in hammering the cotters down. Though others applied bushes to the rods of six-coupled goods engines, Ramsbottom himself confined them strictly to four-coupled passenger engines, and in all his goods engines used brasses and cotters. It was not until 1873 that F. W. Webb applied bushes to the six-coupled engines of the L. and N.W.R. On the G.W.R. J. Armstrong, between 1868 and 1876, compromised by fitting bushes to the crank pins of the leading and trailing wheels only, retaining cottered brasses for the driving pins. Ramsbottom and Kirtley used bronze bushes. Adams and McDonnell used cast iron lined with white metal, and after 1873 Webb forced solid white metal bushes into the coupling rods.

Joseph Beattie's semi-circular balanced slide valve was at this period applied to many of the L. and S.W.R. express engines. The valves were of hard cast iron with two cast iron packing rings, and, though somewhat complicated, were very successful.

The convenience in "notching up" with the screw reversing gear induced several designers to combine a screw with the reversing lever for the purpose of reversing quickly, and also of putting the engine into full gear immediately steam was shut off. W. Bouch's arrangement of 1865,[1] used on a number of N.E.R. engines, consisted of a torpedo-shaped screw on which a square thread was cut. The catch of the reversing lever could be moved into or out of the continuous notch formed by the screw thread. This reversing gear was applied by R. Stephenson and Co. to a considerable number of engines.

A different design for an engine by Sharp, Stewart and Co. is shown in Plate XXIV. of Colburn's "Locomotive Engineering." The boss of the reversing wheel had a trunnion nut attached, which was pivoted on a pin at the back end of a plain sector. The reversing screw passed through the lever in such a way that a half nut attached to the trigger rod could be made to engage in the thread, in which case the lever moved slowly as the hand wheel was rotated. In mid-position the screw was horizontal, but the position of the trunnion pivot was such that as the lever moved

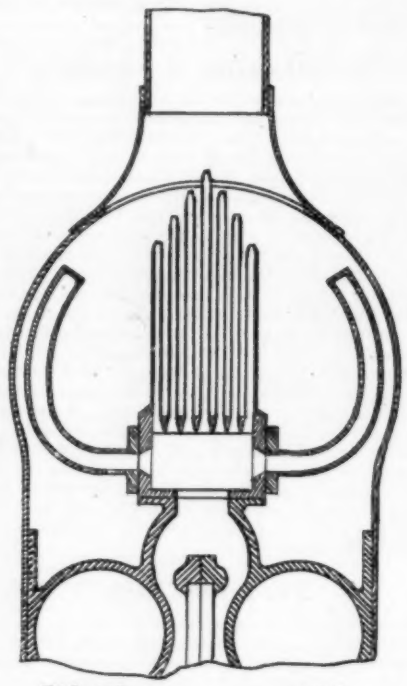


FIG. 188—BOUCH'S BLAST PIPE

into fore-gear the screw and wheel turned through an angle about the pin and the screw assumed a position inclined downwards towards the front. In back gear the inclination was upwards towards the front. This arrangement was invented about 1862–3 by M. Belpaire and was applied to nearly all the locomotives of the Belgian State Railways. Edward Fletcher, on the N.E.R. express engine, used a modification of Bouch's gear mentioned above, but there were very few other applications of the combined lever and screw on British railways.

Fire-box Water Tubes.—In 1868 James Pearson, of the Bristol and Exeter Railway, applied water tubes to the fire-boxes of the reconstructed 4–2–4 tank engines—Fig. 104 *ante*. There were five tubes, each about 4in. internal diameter, placed transversely in an inclined position. Upon these brickwork rested, forming a flattened arch. The tubes were screwed at both ends into an angle collar, the latter being riveted to the fire-box sides. There do not appear to have been any facilities for cleaning the tubes, which were removed after a few years' service.

In 1861 R. Stephenson and Co. designed a boiler for the Metropolitan Railway, with a long circular combustion chamber having 250 transverse water tubes 1¼in. diameter. This boiler does not appear to have been made.

Safety Valves.—The Naylor safety valve—Fig. 187—introduced about 1866 by Kitson and Co., was for some years standard on the Lancashire and Yorkshire and the North-Eastern railways. Its object was to overcome the defect of the increased force on the back of a direct spring-loaded valve as the latter lifted and compressed the spring. The spindle of valve V acted on the end A of a bent lever, the other end B of which was attached by a stirrup to the spring. As the valve lifted the horizontal distance between the spindle and the fulcrum F decreased only very slightly, but the end B, was by its rotation brought very much nearer to the vertical line through F, and the leverage on this side considerably decreased. Therefore the moment of the force lifting the valve remained practically constant, whilst the opposing moment exerted by the spring was greatly lessened. For a time these valves bid fair to rival the Ramsbottom duplex valves, but the latter had the advantage that the driver could ease them regularly by using his lever, whereas the enclosed Naylor valves, in case of sticking, were inaccessible.

Blast Pipe.—It is perhaps in the fitness of things that the Stockton and Darlington Railway, on which Hackworth's contracted nozzle first appeared, should have been the line upon which one of the most extraordinary designs of blast pipe was tried by W. Bouch. This arrangement—Fig. 188—which bore some sort of resemblance to a church organ, had two objects in view, viz., to produce a continuous instead of intermittent blast, and to give greater surface of jet for entraining the gases. The exhausts entered a rectangular chamber to which two bent pipes with closed ends were attached. The action of these reservoirs was presumably intended to be similar to that of the air vessel of a pump. The blast pipe or pipes took the form of a number of open-mouthed tubes of different heights, through which the steam was discharged continuously into the chimney.

It is interesting to observe that the old piston plug theory of the action of the steam in the chimney was by no means held by all engineers. J. A. Longridge in 1852 pointed out before the North of England Mining Engineers that the effect of the jet of steam was a frictional action between the surface of the jet and the surrounding air.

Sand Boxes.—W. Adams in the North London engines placed a single sand box on the boiler. The outlets were arranged in a horizontal base plate, and each was closed by a cone at the bottom of a vertical rod actuated by lever gear from the footplate. Cudworth on the S.E.R. also began to place the sand box in the boiler for the purpose of keeping the sand dry. In this case a square box surrounded the base of the dome. Sand boxes on the boiler have never found favour in this country, owing to the tendency to spill sand, which finds its way to the motion.

Cabs.—The elaborate American cab on Stephenson's engine of 1860 (Fig. 154 *ante*) might be expected to have been received with favour, but that was far from being the case. There were two obstacles. Many locomotive superintendents considered that if drivers were made too comfortable some were prone to fall asleep on duty, but it is also true that the drivers themselves objected to being closed in. They were a hardy lot in those days. The usual protection consisted merely of a flat weatherboard placed at the back on the top of the fire-box casing. On the Midland Railway in 1863 some boys threw bricks down from an overbridge at Loughborough, severely injuring a driver, after which M. Kirtley gave better protection by bending the top of the weatherboard completely over the footplate, supporting it at the back by means of two columns. This form of weatherboard rattled when the engine was running, and the twenty engines

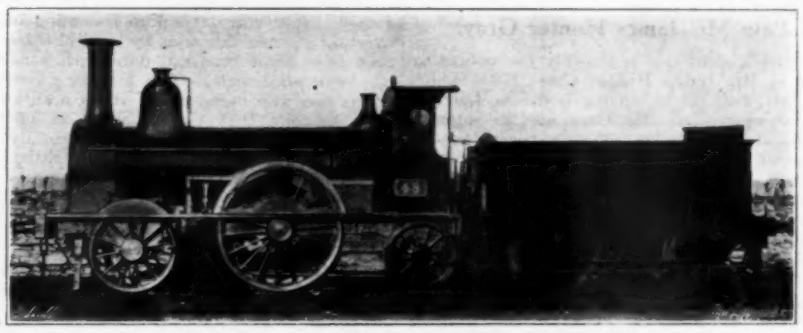


FIG. 189—G. S. AND W. RAILWAY EXPRESS ENGINE, 1858 - 1863

or so fitted with it were known as the "drummers." The drivers objected strongly to it, and asked for its removal. A compromise was reached whereby the weatherboard was bent over part only of the footplate and was not supported by pillars. This arrangement, shown in Fig. 177 *ante*, was standard on the Midland until 1872. Sacré, on the M. S. and L. R., adopted the completely covered over footplate about 1865, supported the bent weatherboard by columns, and retained it until 1877 in spite of the "drumming."

The early Great Western experience with iron-roofed cabs, of which a number were applied in 1872-3, was similar to that of the Midland. The drivers objected to the rattling and a return was made to the old straight front weatherboard, which gave hardly any protection whatever. Later G.W.R. cabs from 1876 onwards had roofs with wood battens. P. Stirling built no engines after 1863 without cabs, but their

* No. XXIII. appeared June 5th.

[1] Illustrated in "A Century of Locomotive Building," by J. G. H. Warren, and in "The Development of British Locomotive Design," by the writer.

use on most railways was deferred until about 1870–1877, according to the particular views held by the different locomotive superintendents. It was not until 1886 that the Stephenson "American" cab of 1860 was re-introduced by T. W. Worsdell on the N.E.R.

LOCOMOTIVES FOR IRELAND AND OVERSEAS, 1860–9

Ireland.—With very few exceptions, locomotives in Ireland were similar in general design to those on this side of the Irish Channel, though of smaller size, since train loads were lighter. The cylinders were in nearly all cases inside. The majority of the main line "single" engines were of what may be termed the "McConnell" type, with all bearings inside the frames. The first engine built in Ireland in 1845 at the works of Grendon and Co., Drogheda, for the Dublin and Drogheda Railway, was of that type. An express engine of the Great Southern and Western Railway, built at the Inchicore Works of the company, during the 1858–1863 period, to the designs of John Wakefield, is shown in Fig. 189. The cylinders were 15in. by 22in., and the driving wheels 6ft. 6in. diameter. As in McConnell's engines, the leading wheels were of large size, 4ft. 6in. diameter, but the trailing wheels were only 3ft. 8in. diameter. But the engines differed in that the wheel base, 14ft. 10in., was shorter.

A number of 2–2–2 engines of similar type, but of neater design, were built by Beyer, Peacock and Co., for the different railways which afterwards were amalgamated into the Great Northern Railway of Ireland.

Most of the 2–4–0 engines, with the exception of those on the Ulster Railway and on the Belfast and Northern Counties Railway, also had inside bearings throughout. Fig. 190 shows a standard design by Beyer, Peacock and Co., 1866, for the Dublin and Belfast Junction Railway. The engines had 6ft. coupled wheels and 16in. by 22in. cylinders, whilst others of the same general design for the Dutch State Railways, 1864–1872, of which there were sixty, were somewhat smaller, with 5ft. 6in. coupled wheels and 16in. by 20in. cylinders.

In 1869 Alexander McDonnell designed a number of 2–4–0 express engines, also of the type with inside frames throughout, for the Dublin–Cork services of the Great Southern and Western Railway. They had 6ft. 7in. coupled wheels and 16in. by 22in. cylinders, increased to 17in. by 22in. in the later engines of 1875. One of them was illustrated in THE ENGINEER, September 5th, 1879, page 184. In appearance they were extremely like Ramsbottom's engines on the L. and N.W.R., but differed from the latter in that the fire-box casing was raised slightly above the barrel, and the valve motion was of the suspended swing link type, instead of having rectangular valve spindle guides. The total heating surface was 931 square feet, of which the fire-box provided 96 square feet. The grate area was 17¼ square feet and the weight in working order 30 tons 0 cwt. 2 qr.

Goods engines were mostly of the 0–4–2 type, with inside frames, 5ft. coupled wheels, and 16in. cylinders, having 22in. or 24in. stroke. The use of these engines was almost universal throughout Ireland, though a number of 0–6–0 engines, with 17in. by 24in. cylinders, were placed in service from 1867 onwards. Sectional drawings of one of John Wakefield's 0–4–2 engines on the Great Southern and Western Railway are given in Colburn's "Locomotive Engineering," Plates 34 and 35, and one of Neilson's engines for the Dundalk and Enniskillen Railway was illustrated in THE ENGINEER, December 1st, 1922, page 571.

Owing to the width of the Irish gauge—5ft. 3in.—double frames with outside bearings were uncommon, except on the railways in the north of Ireland, since sufficiently long bearings could be obtained with inside frames only. An exceptional instance is afforded by the 0–4–2 engines—Fig. 191—of which four where built in 1866 by Beyer, Peacock and Co. for the Ulster Railway, with 5ft. coupled wheels, 3ft. 6in. trailing wheels, and 17in. by 24in. cylinders. They are interesting in that they were the last 0–4–2 goods engines with double frames of the old Stephenson type of 1833 to be constructed in this country. The much more modern framing and general details and fittings of these engines were characteristic of Beyer, Peacock's practice.

Of passenger tank locomotives there was a considerable number of 2–2–2 engines of the "Fairbairn" type with inside bearings for all wheels, principally on the Dublin, Wicklow and Wexford and Midland Great Western railways. This type has already been mentioned and need not be further considered.

The type of 0–4–4 back tank engine—Fig. 192—built in 1869–1870 at Inchicore Works, to A. McDonnell's designs, was a novel departure, and merits special mention. It was what may be termed a single Fairlie with front coupled wheels, which formed a steam bogie. The hind bogie was of the Adams type, with lateral movement and india-rubber pad. The pivot of the steam bogie had a flat face, which rested in a recessed socket. Though nearly all the weight was carried on the pivot, there were also india-rubber load check springs on each side in a cup bracket attached to each main carrying frame. This arrangement allowed the steam bogie and carrying frame to tilt together laterally, whilst the trailing Adams bogie could also tilt independently of the main frame. The pitching movement of the steam bogie was controlled by rubber check springs fixed to a bracket carried centrally on the transverse stay in front of the fire-box. The springs of the coupled wheels were connected by compensating levers, and the trailing bogie had a single inverted spring on each side. The steam pipe, 3in. diameter, was taken out from the front of the dome into a tee piece, from which two external pipes passed round the boiler to a tee joint underneath on the centre line of the engine. From this joint a single bent pipe conveyed the steam to the valve chest between the cylinders. The elasticity of the pipes and bends was relied upon to accommodate the movements of the steam bogie, and there was no swivelling joint as in modern articulated engines. The blast pipe was provided with a petticoat pipe, the lower mouth of which was large enough to allow the bottom portion of the pipe to move within it.

The cylinders were 15in. by 20in. and the coupled wheels 5ft. 7½in. diameter, had a wheel base of 6ft., the pivot being 2ft. 7in. in front of the driving wheel. The trailing bogie wheels, 2ft. 11in. diameter, had a 5ft. wheel base. The distance between bogie centres was 14ft. 7in.; total wheel base, 20ft. 6in.; weight on steam bogie, 22 tons; total weight, 35 tons 17 cwt.; water tanks, 800 gallons; fuel, 30 cwt. Sections of these engines are shown in Colburn's "Locomotive Engineering," plate 47.

Only two of these Fairlie engines were built. Whether the steam pipes gave trouble the writer does not know definitely, but in a large number of 0–4–4 tank engines, which were built subsequently at Inchicore between 1871 and 1884 on somewhat similar lines, the steam bogie was suppressed, and the leading coupled wheels were arranged with bearings in the main frames in the usual manner. In the latter engines, one of which was illustrated in THE ENGINEER, September 5th, 1879, page 184, the trailing bogies were provided with outside bearings.

India.—A few of the more interesting types built for Indian railways may be briefly mentioned.

In 1861 the East Indian Railway adopted engines with outside cylinders in place of those with inside cylinders previously used, in spite of the advantage which the 5ft. 6in. gauge allowed for longer bearings and wider crank webs. The change may have been in part due to the influence of Robert Sinclair, who acted as consulting engineer for the designs, and who was an out-and-out advocate of outside cylinders. Of the two designs mentioned below the drawings were, the writer believes, prepared by the late Dr. W. H. Maw.

The 2–2–2 "mail" engines were built by the Vulcan Foundry, Neilson, and Beyer, Peacock, 1862 to 1865. Cylinders, 15in. by 22in.; wheels, 3ft. 9in. and 6ft. 6in.; wheel base, 6ft. 8in. + 8ft. 2in.; total heating surface, 1109¾ square feet; grate area, 18 square feet. The footplate was protected by an arched roof.

No less than 285 2–4–0 mixed traffic engines were built from 1861 to 1868, and were for many years standard for all passenger and goods services on the East Indian Railway, except the mails and faster expresses. The cylinders were 16in.

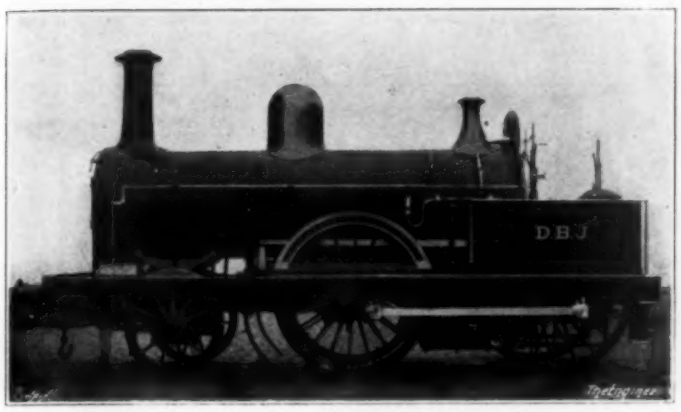


FIG. 190—ENGINE FOR THE DUBLIN AND BELFAST JUNCTION RAILWAY, 1866

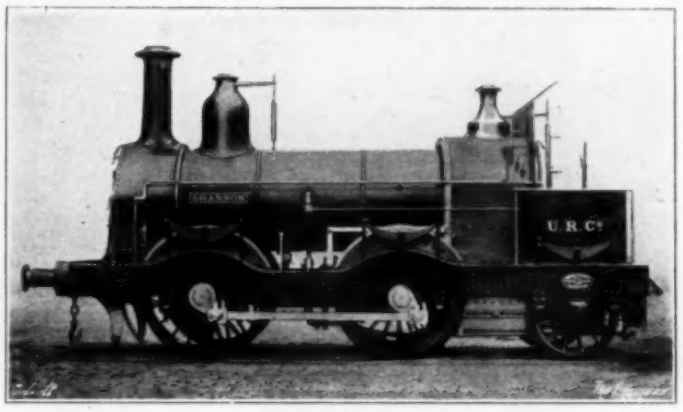


FIG. 191—BEYER, PEACOCK ENGINE FOR THE ULSTER RAILWAY, 1866

FIG. 192—McDONNELL'S BACK TANK ENGINE, G.S. AND W. RAILWAY, 1869

by 22in.; wheels, 3ft. 7in. and 5ft. 7in.; wheel base, 15ft. 4in.; heating surface of tubes, 1009 square feet, of fire-box 97 square feet; total, 106 square feet. In this connection it may be added that the tubes of most of the class were 2¼in. outside diameter, although their length was only 10ft. 11in. Pressure, 120 lb.; weight in working order, 32 tons 14 cwt., but the distribution on the coupled wheels was very unequal, as the driving pair carried 12 tons 11 cwt. and the trailing pair only 8 tons 13½ cwt.

The above dimensions have been taken from those published by D. K. Clark relating to the engine by Armstrong in the London 1862 Exhibition. Kitson's drawings show a wheel base of 6ft. 2in. + 8ft. 8in. = 14ft. 10in., and a total weight of 31 tons 12 cwt., of which 12½ tons rest on the drivers and 9 tons 4½ cwt. on the trailing wheels.

Incidentally some new locomotive manufacturers took part in the building of these engines, in addition to the old-established firms of Kitson, Hawthorn, Avonside Engine Company, and the Canada Works. Amongst the newcomers were W. G. Armstrong and Co., of Newcastle, who showed one at the 1862 Exhi-

bition. After building about twenty Armstrong's gave up locomotive work, to reappear in 1919 in this branch of engineering. Another Newcastle firm, J. Morrison and Co., built ten in 1867, and then disappeared completely. Cross and Co., of St. Helens, also made thirty in 1866–7. The first locomotives built for India by continental firms were included in the class. Of these twenty were made by E. Kessler, of Esslingen, one of which was at the Paris Exhibition of 1867, and ten others came from the works of Escher Wyss and Co., of Zurich.

Although a limited number of 2–4–0 outside cylinder engines were built from 1866 to 1870 for other Indian main lines, the type was not perpetuated, and the standard British inside cylinder engines of the period, mostly of the 2–4–0 and 0–6–0 types, formed the great majority of those sent to that country.

The mixed traffic engines of the Scinde, Punjaub, and Delhi Railway, afterwards the North-Western State Railway, were of the 0–4–2 type. They had kept the Patent Office of that day out of other mischief. The driving wheels were 4ft. in diameter, and the 16½in. by 24in. inside cylinders were steeply inclined. The crank shaft bearings had adjusting wedges both in front and behind, and the axle-boxes of the end pairs of wheels had 1¼in. lateral movement in the guides, the coupling rod pins being long enough to allow for it. The springs were cambered slightly upwards, the plates being of the same length but tapering in width from the middle to the ends. They were also of the "open-plated" form, that is, a thin packing plate was inserted between each main plate at the buckle, so that the ends were not in contact with each other. This construction was adopted to bring the plates into action successively. The axle bearings were 9in. long and only 5½in. diameter. The chimney top was bevelled from front to back, and a central buffer only was provided. The engine, which was built for light rails, weighed only 30 tons.

The heavy 0–8–0 tank engines for the Ghât inclines of the G.I.P.R. superseded the 4–6–0 tank engines spring gear, in which a very large number of rubber washers were interposed between the adjusting nuts and the frame brackets and compensating levers. The coupling rods had circular bushes of steel.

As the Bissell two-wheeled truck did not appear in this country until 1860, whereas the four-wheeled bogie was made for engines exported to America in 1833, the 2–6–0, or "Mogul," engine was of considerably later date over here than the 4–6–0 type. The latter had been built for South America by Hawthorn, in 1860, but as far as the writer can trace, the first 2–6–0 locomotives built here were 3ft. 6in. gauge engines made by Neilson and Kitson in 1866–9 for the Queensland railways. The first 2–6–0 engines for a British railway did not appear until 1879.

The type of 2–4–0 tender engine—Fig. 195—which was built in 1862 by Beyer, Peacock and Co., for the Tudela and Bilbao Railway (Spain), of 5ft. 5½in. gauge, is one which was never used on any British railway. The leading axle formed a Bissell truck, controlled by inclined planes, but instead of the in-

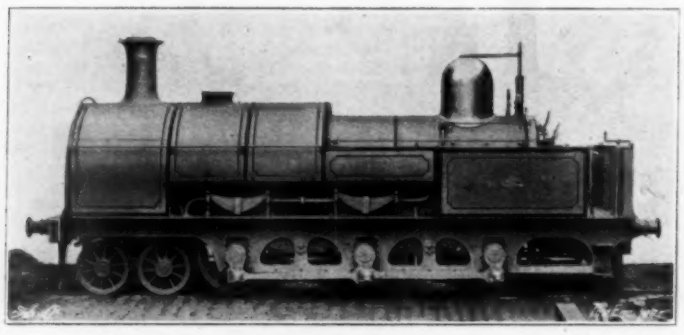


FIG. 193—GHAT ENGINE, G.I.P. RAILWAY, 1862

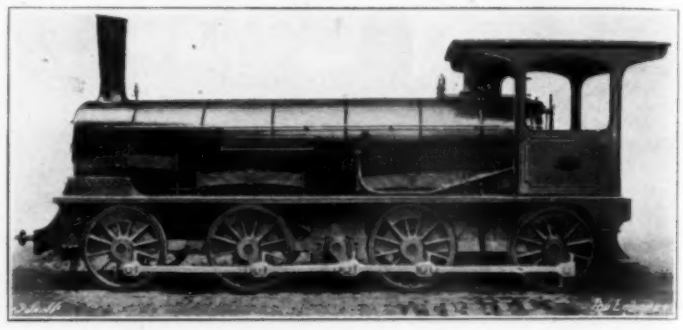


FIG. 194—ENGINE FOR THE OUDH AND ROHILKHAND RAILWAY, 1865

17in. by 24in. cylinders and 5ft. 6in. front coupled wheels. All were built by Stephenson and Kitson, 1867–1870.

Other engines for India described below never had any counterparts in this country. The 4–6–0 saddle-tank engines—Fig. 193—of which there were five, were built in 1862 to the general plans of J. Kershaw, by Sharp, Stewart and Co., for the Ghât inclines of the Great Indian Peninsular Railway, to replace the back-to-back twin engines previously used. Sectional drawings appear on Plate VI. of Colburn's "Locomotive Engineering," but, so far as the writer is aware, no outside view which shows the peculiar arrangement of saddle tanks has hitherto been published. The main outside frames were of the old sandwich type, and the writer believes that these were the only engines ever built for the Indian broad gauge with outside frames and cranks. Other peculiarities included the sledge brakes, compensating levers producing three point suspension for a ten-wheeled engine, and a bogie with the ridiculously short wheel

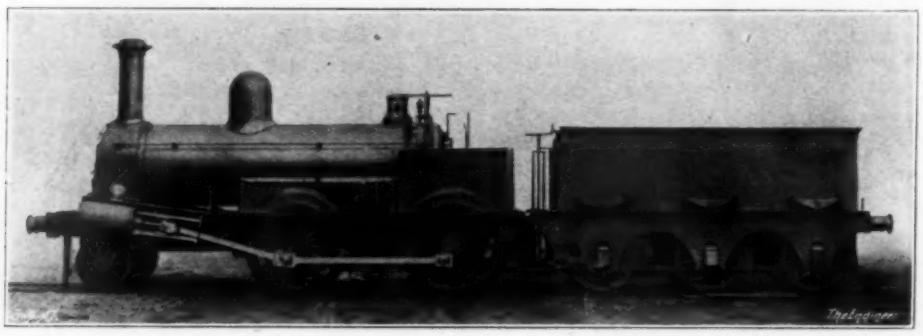


FIG. 195—ENGINE FOR THE TUDELA AND BILBAO RAILWAY, 1862

base of 3ft. 2in. for a 5ft. 6in. gauge line. This bogie could slide laterally under the engine, and appears to have been the first made in this country with this arrangement, but unlike Adams's bogie which followed, the controlling force was supplied by inclined planes, as in Bissell's trucks. The cylinders were 20in. by 24in., the first to be made of that size for a British built locomotive, antedating those of the St. John's Wood engines by five years. Owing to the wide gauge, it was possible to place the steam chests between them. Other dimensions were:—Coupled wheels, 4ft. 4in.; bogie wheels, 2ft. 9in.; coupled wheel base, 12ft. 10in.; total base, 19ft. 10in.; the driving tires were flangeless; total heating surface, 1438 square feet; grate area, 25.9 square feet; weight on coupled wheels, 37¼ tons; total weight, 49 tons.

The peculiar eight-wheels coupled engines with intermediate driving shaft—Fig. 194—were made in 1865 by Sharp, Stewart and Co., for an "Indian Branch Railway," later the Oudh and Rohilkhand. They were built under James E. Wilson's patent, which, if it included the intermediate shaft, was one of those perennial "improvements" which described above from 1866 onwards, when the first twenty were built by Kitson. They had inside cylinders 18in. by 24in. and 4ft. wheels. This remained the standard type for about thirty-five years, though in the later engines the stroke was increased to 26in. In all, about 85 of the class were built by Kitson, Neilson, and Vulcan Foundry, a few of them being supplied to the North-Western State Railway. An engine of this class was illustrated in THE ENGINEER, December 1st, 1922, page 580.

The somewhat similar 0–8–0 tank engines for the Mauritius Railway—4ft. 8½in. gauge—also with inside cylinders, 18in. by 24in., built 1867 by Sharp, Stewart, were illustrated in THE ENGINEER, August 31st, 1923, page 231. These engines had a total wheel base of 15ft. 6in., and the end axle-boxes had a lateral play of ¼in. each way.

OTHER LOCOMOTIVES FOR OVERSEAS.

In 1868 Neilson and Co. built 25 4–4–0 American type engines for the Grand Trunk Railway, Canada—at that time of 5ft. 6in. gauge—to the drawings and templates provided by R. Eaton, chief locomotive superintendent of the railway. They were American in all essentials except that shallow plate frames instead of bar frames were employed, and the fire-box casings were flush with the barrel. The bogie was of the trussed diamond truck pattern without side play, and with no other springs beyond a block of india-rubber on the flat centre plate, and two small rubber springs at the sides of the transverse beam. The bogie wheels were of chilled cast iron; the fire-box of wrought iron, but the tubes of brass. The chimney was of flattened "diamond stack" type, with spark arresting top 6ft. diameter. The weigh-bar shaft was counterbalanced by a coiled spring. These engines had 16in. by 26in. cylinders and 5ft. 1in. coupled wheels.

The extremely neat 4–4–0 engines by Fox, Walker and Co., 1868, for the Windsor and Annapolis Railway, Nova Scotia, are illustrated in "Colburn," plate 46. With the exception of the polished mahogany American type cabs they were of British design throughout. The principal detail of interest was the elination of 1 in 6 which proved unsatisfactory on Sinclair's Great Eastern tank engines, the more moderate inclination of 1 in 11 was provided. These engines, which were built for mixed trains at very moderate speeds, over a road with many curves, had a wheel base of 10ft. + 8ft. The cylinders were 16in. by 24in., and the driving wheels were 5ft. diameter; weight in working order about 29¼ tons. Several are still in service in the locomotive stock of the Northern Railway of Spain, but the compensating levers between the springs of the coupled wheels have been removed.

Figs. 189 and 192 above and 182–3 in our last issue are from photographs by the Locomotive Publishing Company, Ltd. Fig. 174 *ante* is from a photograph by Mr. R. E. Bleasdale, and for Figs. 170, 176 and 181 *ante* the writer is indebted to drawings by Mr. G. F. Bird.

The Deutsches Museum, Munich.

(By a Special Correspondent.)

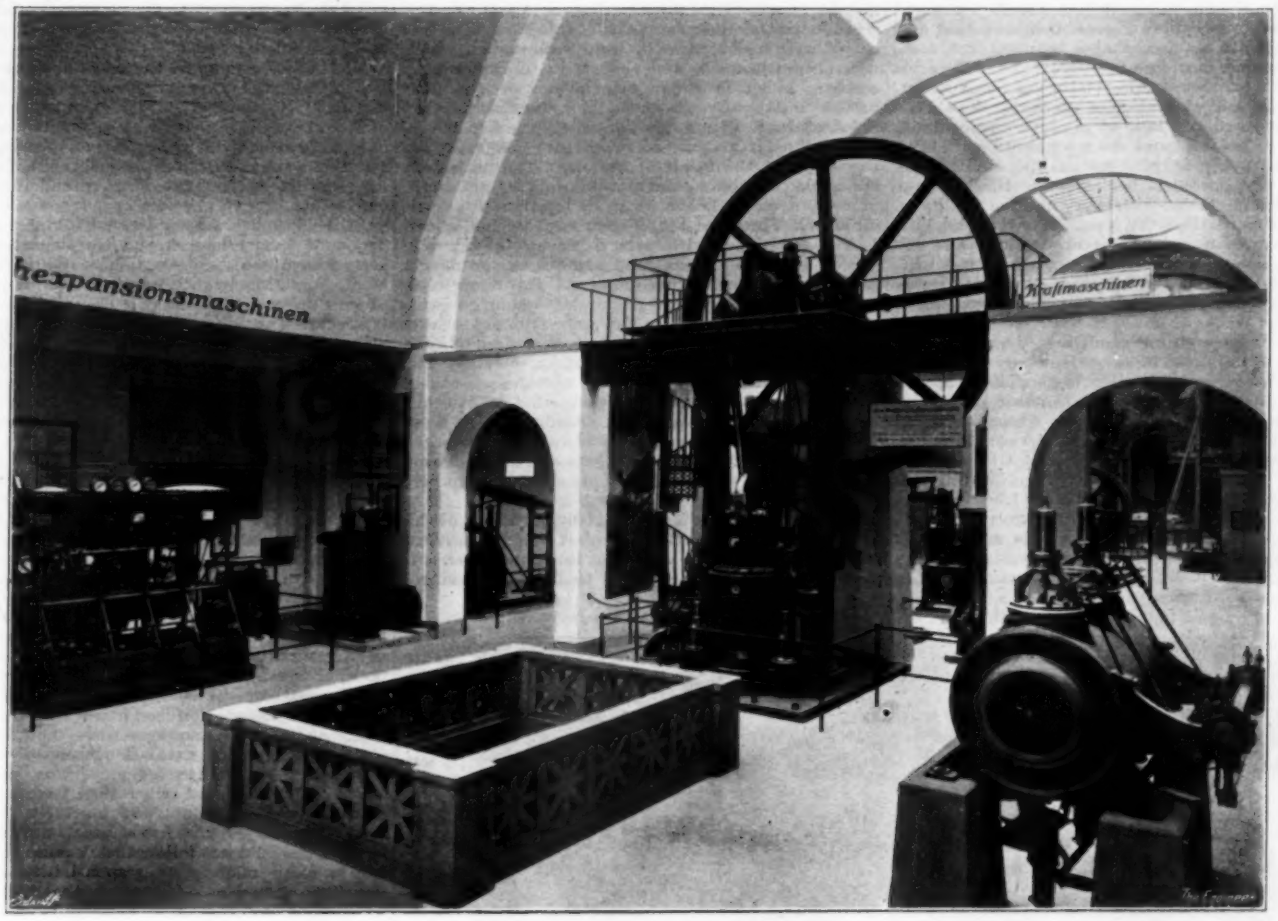
IN the ordinary man the mention of the word "museum" arouses only the most tepid interest; if, indeed, it occasions any response at all. Hence, when we find an outburst of patriotic enthusiasm on the part of a whole nation over the opening of a museum, and one largely concerned with engineering, the phenomenon appears to be one worth some examination.

The museum in question—the Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik, to give it its full title—is situated in Munich, Germany. The opening took place on May 7th, and the event has been but little noticed in the English Press; hence this article. The aim of the Museum is to illustrate in three dimensions the rise and progress of engineering and applied science; in fact, it attempts, very successfully too, to bring to the knowledge of the people information and instruction as to the fundamental discoveries and inventions upon which modern civilisation is reared. The scope of the Museum may most easily be defined by saying that it is very nearly that of our Science Museum at South Kensington.

The Deutsches Museum was founded in 1903, and in 1906 the foundation stone of the building that has just been opened was laid by the Kaiser, assisted by other royalties, so that the recent festivities are the climax of twenty years of very hard work.

Although, contrary to what most of us would expect from Germany, the Museum is in no sense a State institution, since it has been built up very largely by the foresight and wisdom of Dr. Ing. Oskar von Miller, a well-known consulting electrical engineer. He is consultant to the Walchensee Kraftwerk, a power scheme fast approaching completion that will supply Munich and a large part of Bavaria with power, light and heating. The interest taken in the Museum has been shared officially by the Government, the State of Bavaria and the city of Munich, as well as by the Institution of German Engineers, learned societies, universities, high schools and the

THE DEUTSCHES MUSEUM AT MUNICH



THE PRIME MOVER HALL

leading industrial and commercial men throughout Germany.

One reason for the enthusiasm that has been and is being displayed appears to be that since the war there has arisen in Germany a conviction that she must look to technical progress in all branches of applied science to meet the Reparation demands and to re-establish the position that she lost owing to the war. The opinion is that, not only the intellectuals, but the whole body of workers must be raised to a higher level of comprehension; the hope and expectation is that the Museum will play a great part in this direction. It is just as well to be alive to the fact that German engineers collectively are making strenuous efforts to improve workshop performance.

Indeed, the time may not be far distant when the German engineer, instead of as in the past the German Army, will be held up in the Yellow Press to scare nervous people. Another reason is perhaps psychological. After a period of humiliation, a person is ready to hug some meritorious performance on his part to restore his self-esteem; and so with a nation. A third reason for the enthusiasm is that the German people really do value education, and do not look upon it as a luxury that can be afforded only as long as taxes can be kept down.

The opening of the Museum was accompanied by every mark of public rejoicing, such as has not been seen anywhere since the war. The city streets and the shops were tastefully decorated by Munich artists. On Tuesday, May 5th, a procession took place in which horsed cars allegorical of the scope of the Museum and representative of craft and industry appealed to the admiring throng. The actual opening on Thursday, May 7th, was marked by a play, specially written by German's foremost poet, Gerhard Hauptmann, and played by actors from the City Theatre. The opening had been arranged to coincide happily with the seventieth birthday of Dr. Oskar von Miller, and naturally gifts were showered upon him.

The Deutsches Museum has been conceived on an imposing scale, as will be seen from our illustration, in a fine position on an island in the river Isar, on which Munich stands. The site itself and practically all the material and fittings that have gone into the construction of the building have been presented. The material is reinforced concrete without any facing. The dimensions are 345ft. by 325ft. by 80ft. high. The tower is 210ft. high. On the ground floor the whole area is exhibition space, but on the three floors above this the plan is a hollow square, which affords excellent lighting. The cubic content is about 9½ million cubic feet. The floor area is about 350,000 square feet. Above the roof level there are three domes, all of which have been designed to hold telescopes; in fact, one of them is practically an astronomical observatory. Even the tower is utilised as a huge barometer. The entrance to the Museum is by a handsome vestibule on the north side, whence stairs and lifts give access to all floors.

VIEW OF THE MUSEUM FROM THE SOUTH-WEST

The collections, which have been in course of formation in temporary premises since the inception of the Museum, are arranged systematically. Hence, we find an introduction is made through geology in its economic aspect, as touching the source of raw materials for industry. From this it is but a short step to mining, of which a fascinating exhibit has been arranged in two basements, approached by a winding staircase in the north-east corner. It consists in a representation in actual size of ore, stone, salt and coal mines, so arranged that the visitor sees figures of miners engaged in sinking, stoping, timber-

ing, hauling, drilling, &c., as he passes through in a consecutive manner. Here, as everywhere else, an attempt is made to contrast the old and the new; hence we find mining tools of the Stone Age in juxtaposition with the pneumatic drill or the electrical coal cutter. The preparation of ores, their smelting and the working into required shapes by moulding, casting, forging and machining is displayed. Here we meet what is another striking feature of the Museum, and that is the representation of interiors. We almost stumble into a dimly lighted scythe forge of 1803, with its trip hammer and the very forge scale from the work in progress lying around the anvil. This forge was transported hither from the Black Forest and has been re-erected with every mark of fidelity.

The large side hall, 200ft. long, 57ft. wide and 44ft. high, is devoted to prime movers, and to stress the fact that all these machines derive their energy ultimately from the sun, a striking allegorical fresco painting by Fritz Gartner, a well-known artist, occupies the whole of one end wall. It would take up too much space to tell of all that there is in this hall. Something must be taken and more imagined from our illustration. Nearly every engine is capable of being set in motion by an electric motor.

We now come to land transport, where again the primitive means by sledges, &c., can be seen in juxtaposition to wheeled vehicles, the steam locomotive, the motor car and the electric train. Naturally, to accompany the locomotive there is its track, so that we find the construction of roads, railways (ordinary, mountain and rope), bridges, viaducts and tunnels following in quick succession.

River regulation leads to dams, weirs, canals, harbours, docks, and thence. by an easy gradation, to shipping. To the latter the large central hall is to be devoted, but as it was required for the opening ceremony, the objects are not yet all in place, although they are ready to put into position. One object is, however, in its place, built into the basement—the first German submarine, shown in half longitudinal section. When the Allied Commission heard of the intention to make this exhibit, it saw a grand opportunity to show how busy it could be, and had the vessel broken up. The directors of the Museum have, however, had it all reproduced in dummy so faithfully that at the distance the visitor sees it he cannot tell that it is not real.

Air transport and flying generally is accommodated in the upper part of and in the galleries around the large hall allocated to ships.

The visitor has now traversed the ground floor—and if he does all the other floors as thoroughly he will have walked 10 miles—but before ascending to the first floor he comes across another feature upon which stress is laid in the Deutsches Museum, and that is the human side of it all. Over the vestibule is the Hall of Honour, devoted to portraits, statues, busts, &c., of men who have advanced engineering and scientific knowledge in their broadest aspects. Less famous men will be found enshrined in smaller halls of honour, scattered throughout the various sections, or perhaps a portrait of a man will be shown near the representation of his isolated invention or discovery.

We have not space to treat in detail the collections housed on the first, second, and third floors, nor is it perhaps necessary to do so, as they are not of such great interest to our readers as those just described, but they should enumerated. They are:—Standards of measurement and metrology, mathematics, mechanics, heat, electricity, optics, sound and musical instruments, chemistry, building construction, town planning, water supply and purification, heating, ventilating, lighting, gas manufacture, electrotechnics, astronomy, geodesy, textile industries, paper making, writing, printing, illustration, agriculture, corn milling, brewing and distillation.

Some of the interiors in these sections must be seen to be appreciated thoroughly, but we may cite the alchemist's laboratory—see below—of the Middle Ages, a paper mill of the early eighteenth century, a monk in the Scriptorium illuminating a missal, and a reproduction of Gutenberg's printing office. There is one other interior, of a totally different kind, which must be mentioned, and that is in the astronomy section. It is a Ptolemaic planetarium, designed and worked out by Dr. Bauersfeld, of the firm of Carl Zeiss, of Jena. Here in a darkened chamber images of the fixed stars of the northern hemisphere are thrown upon the inside of a dome. The projection apparatus can be set in motion, so that the daily movement of the heavens can be reproduced in four minutes. Furthermore, by means of a smaller projector, combined with orrery gearing, the yearly course of the sun, moon and planets can be passed over in the space of five minutes. The effect is so astonishing as to leave one almost speechless with admiration and pleasure. The apparatus has created such a furore that already, we are informed, ten similar devices have been ordered for cities in Germany and in other countries, but not one is destined for Great Britain! It will be a lasting reflection on our insularity if any time is lost in installing one of these planetaria in this country, preferably in London. If it were done merely as a monetary speculation it would return a profit, supposing any higher motive to be absent.

Admission to the Museum is by payment of 6d. per adult, children half price; but there are several ways of obtaining cheap tickets for schools, &c. As the object of the Museum is to help the younger generation particularly, and as railway travelling is now much dearer in Germany than it was before the war, an endowment fund has been created, out of which are defrayed the expenses of selected young persons to spend a week in Munich and visit the Museum. To this fund the Reichstag has just voted the sum of £5000. To spend a week in such a charming city at an impressionable age cannot but have a life-long effect on the fortunate bursar.

It may be asked quite pertinently how it is that the Museum has achieved the success indicated above, with all the difficulties due to closing down during and after the war, the revolution and the period of monetary inflation subsequent to the war. The only answer that can be given is that it is owing to the wonderful influence of Oskar von Miller and the wholehearted devotion of the people of all classes and means. As an example of the latter, the writer is able to cite, from his own knowledge, the action of workmen in the shops of the Bavarian State Railway (now Reichsbahn), who voluntarily undertook on Saturday afternoons and on Sunday mornings before church to help in the installation of objects in the new buildings: and this, the writer was told, was by no means an isolated instance. We are indebted to the Directors of the Deutsches Museum for the accompanying illustrations.

AN ALCHEMIST'S LABORATORY OF THE MIDDLE AGES

The International Railway Congress.

No. II.*

Level Crossings.

Subject I. B covers the question of public road level crossings, and the question runs as follows:—"Dispensing with Crossing Keepers. Visibility of the Trains from the Crossing. Warning Notices, Signals, &c." There are three reports by continental contributors, none of which would ordinarily be of interest to English readers. But, in view of the high cost of railway operation and bearing in mind that our eight hours' day applies equally to gatemen as to enginemen, shunters and signalmen, it will be of interest to know that in many of the continental countries gatekeepers are being dispensed with, and the public protected solely by signs.

M. Maas-Geesteranus, the engineer-in-chief of the Dutch Railway Company, opens his report by observing that "No doubt one of the most typical examples of the unnecessary use of labour on small lines is that of looking after the barriers at level crossings. . . . For this reason, therefore, the closing of level crossings and dispensing with their attendants has been carried out in several countries."

In Belgium it has been decided to revise the supervision of level crossings, and the departments concerned have been told that, where the traffic crossing is of small importance, supervision may be withdrawn, if, where the speed is 62 miles per hour, the trains are visible for 550 yards from the crossing; where the speed is 37½ miles per hour, for 330 yards; and at 25 miles per hour, for 220 yards. The departments are to cut down all trees, hedges and tall vegetation on ground belonging to the State near the crossings that may obscure the view of approaching trains. Where the attendants have been removed, their houses have been taken down.

In Sweden—the home of the Aga flash-light—light signals have been placed on the roads at their approaches to a level crossing. The signals flash a red light when a train is approaching and a green light at other times. On some secondary lines in Sweden the speed of trains has been reduced to allow for gatekeepers to be dispensed with.

The Association of German Railways provides barriers and gate-keepers at level crossings on secondary lines only where the speed exceeds 25 miles per hour, or where there is a considerable amount of road traffic, or where the view from the railway is insufficient. The Association has, however, concluded that many of the level crossings on the main lines are of less importance, and not so dangerous as many crossings which are unattended on the secondary lines. As so many countries richer than Germany are dispensing with attendants at level crossings, there seems, concludes the Association, no reason why Germany should not follow their example. The laws in Germany relating to responsibility in case of accident are, however, so severe, that it is necessary to examine each case on its merits. It has, therefore, been decided to dispense with barriers at level crossings where the traffic is small on both road and rail and where there is a good view of the line from the roadway, and where the approach of trains is announced by special signals. Warning crosses are to be erected, supplemented, in special cases, by "advanced" signals, 820ft. from the crossing. For double lines of way a double cross; for single tracks, a single cross is used.

The report for France, made by M. Ruffieux, shows that there are 29,787 level crossings in France, exclusive of those in Alsace-Lorraine, of which only 3268 are unguarded; of the latter, 2594 have never been guarded and 674 have now had the barriers removed. The Minister of Public Works has power to modify the requirements of the Act of 1845—which seem to us to be based on the English law as to level crossings—and the French railways estimate that an annual saving of 20 million francs would be effected were the barriers withdrawn from those crossings which are moderately or rarely used, and where the railway is sufficiently visible from the road. It is, to us, instructive to note that in Alsace-Lorraine, though so long under the stricter rule of Germany, only 98 crossings out of 550 are protected by barriers.

Rails and Rail Joints.

Subject II. for discussion at the forthcoming London meeting of the International Railway Congress is:—A, Initial causes of breaking of rails; means employed to reduce the number of these breakages, as much from the point of view of the method of use as from that of the specification of material employed. B, Rail joints: most economical and efficient arrangement. Report No. 1 covers American practice, and was written by Mr. W. C. Cushing, engineer of standards, Pennsylvania System. It opens by pointing out that a rail may fail but not break. The returns made in the United States relate to failures in general; hence they have not always been understood by railway engineers and rail manufacturers in Great Britain and Europe, who have regarded all failures as broken rails.

The true measure of the life of a rail would be the ton-mile of traffic carried, but it makes no allowance for the variations in alignment, which has an important influence on rail failures, as a rail is more severely punished on curves with a short radius than on lines with a greater proportion of tangent track and long radius curves. The American Railway Engineering Association has, therefore, adopted the unit of 100 miles of track and the number of rail failures for each five years of life. Thus at the end of 1922 a record was taken of the rails put in the road in 1917 which were still in service.

For railways with heavy traffic the predominant ratio of each classified type of failure to the total is approximately as follows:—Rails broken owing (A) to internal transverse fissure, 20 per cent.; (B) to

* No. I. appeared June 5th.

ordinary break, 31 per cent.; to flow of metal, 3 per cent.; to crushed head, 7 per cent.; to split head, 17 per cent.; to split web, 21 per cent.; to broken base, 1 per cent. As a general rule, in North America rails are not allowed to remain in the track until they are so much worn that they are unsafe. They are needed in other tracks of different and lesser service, and the important tracks carrying heavy traffic at high speed obtain the advantage of new rail. They are thus kept in a higher condition.

Some very interesting information is given as to the canting of rails. It is observed that a controversy about the merits of the plan has arisen, and the Committee on Stresses in Railroad Track of the American Railway Engineering Association and the American Society of Civil Engineers, has been engaged in making track measurements of both kinds, vertical and inclined, in order to see if new data of consequence may be obtained.

Of yet more interest are the pages in the report which succeed the remarks of the reporter that it is befitting to draw a picture in outline of a hundred years' progress in the construction of the roadway portion of the railway system. That Robert L. Stevens, the president and chief engineer of the Camden and Amboy Railroad, and not Vignolles, designed the flat-bottomed rail is claimed on the evidence of a copy of the tender issued by the former in November, 1830. In 1862 the Pennsylvania bought in England 400 tons of steel rails, and in 1877 Dr. C. B. Dudley, the chemist to the company, was instructed to make an investigation into the chemical composition and physical properties of steel rails, with a view, first, to answering the question why one steel rail has to be removed from the track after perhaps eight months' service, while another lasts ten years; and, secondly, if this investigation succeeded in throwing light on this important subject, to use this information in securing better rails in the future. About 1884–85 the belief that the rail was being worn out or destroyed by excessive wheel loads through lack of sufficient bearing area was gaining ground with increasing intensity, and a committee to study the rail question was appointed by the American Society of Civil Engineers in 1885. That Committee reported in 1889, and was followed by another Committee which was instructed to design standard rail sections. The final report of the second inquiry was made in 1893, and brought about the A.S.C.E. rail. Rails of Bessemer steel continued to give unsatisfactory results from breakage and crushed and split heads. One of the most numerous types of breakage was the half moon fracture in the base. Failures continued to increase with the growing traffic and weights of rolling stock, so that, by the end of the century, concentrated study was put upon the problem again. The American Railway Engineering Association had meanwhile—in 1899—been founded. Its Standing Committee on Rail reported in 1900 that "the A.S.C.E. sections are a step in advance, and we think that no new sections should be suggested until we have had full time to learn from experience the merits of these sections." The Committee thought that sections should be standardised, and the first specifications were submitted to and adopted by the Association in 1902. As the record of rail failures was getting worse, and as the facts were being pressed upon the executive officers of the several railways, the subject was taken up finally, in order to be under concerted effort, by the official organisation of the executive and operating officers of the railways—the American Railway Association—and a Committee was appointed for the purpose early in 1907. The result was the preparation of specifications for Bessemer and open-hearth steel rails and sections for what are known as type A and type B. The sections varied by 10 lb. increments from 60 lb. to 100 lb. per yard, and since then sections of 110 lb., 120 lb., 130 lb. and 140 lb. have been adopted.

The present period has witnessed the passing of Bessemer steel for principal rail manufacture and the almost universal use of open-hearth steel in its stead, together with the introduction of the heavy base and the better balanced American Railway Engineering Association rail. Since the introduction of the heavy base designs, the base failures have been reduced to a very small number. Mr. Cushing says, "In view of the important facts which have been set forth in this note on rail service, culminating in the high duty imposed by massive loads and extraordinary traffic upon a material of limited strength, it appears to the reporter that we are driven pretty hard to discover such improvement as can be made in the manufacture of rail steel to keep up with the advancing punishment. We ought really to get ahead of it and not to be in the position of always trying to 'catch up,' as seems to have been the state of affairs for many years." An important step in the effort for improvement was the jump from the use of a 100 lb. rail to the heavier weight of 130 lb., 135 lb. and 136 lb. per yard. Before their introduction—about 1910—the increases were made in steps of 5 lb. to 10 lb. per yard. The 125 lb. rail of the Pennsylvania was first rolled in 1915, but was changed to the 130 lb. in 1916. It has been pretty well determined from the study of the Pennsylvania records that the rail failures in 100 lb. rails are from two to two and a-half times as many as in the 130 lb.

Turning to subject II. B—Rail Joints—Mr. Cushing deals first with the length of rails, of which the standard is 33ft. In 1914 it was intended to have a considerable quantity of 30ft. and 45ft. rails rolled in order to gain additional service information. The war interfered with this programme, but it is now being put into effect. The advantage claimed for a longer rail is fewer joints, resulting in a saving of joint material, and of labour for applying and maintaining, and a better riding track. The objections to increasing the length of rail are increased space required at joints for expansion, and greater batter at rail ends, increased number of rail anchors, increased cost of transporting and handling rail, and increased cost of rail owing to changes necessary in rolling mill operations. A reduction in the number of joints is desirable. The joint being the weakest part of the track structure is the hardest to maintain. A study, made several years ago on the western portion of the Pennsylvania system, showed that at least one-half of all surfacing of track needed was at joints. Fewer joints will add to the riding qualities of the track. Signal circuits will be easier to maintain as less bonding will be required.

It is the universal practice of North American railways to lay tracks with alternating—staggered—joints, and they have never looked with favour upon tracks laid with joints opposite one another. It is believed that alternating joints provide stronger and better riding track at less expense. On curves, joints directly opposite one another favour kinks in the line.

Mr. C. J. Brown, chief engineer, Southern Area, London and North-Eastern Railway, is the reporter for the British Empire on Broken Rails and Rail Joints. His report was not, however, available at the time of writing.

Cost of Traction: Fuel and its Combustion.

A phase of railway working that has hitherto received little attention at the hands of the Congress is now covered by Subject IV.: Cost of Traction. It is considered from two directions:—IV. A deals with fuel and its combustion, and IV. B with lubrication of axle-boxes for all rolling stock. Under the first sub-heading there are three and under the second two reports. The full title for report IV. A is "Fuel and its Combustion: (*a*) Choice of Fuel: Coal, Mixing of Coals, Peat, Oil Fuel, Pulverised Fuel, Mixing of Solid and Liquid Fuels—Colloidal Fuel. (*b*) Apparatus for the Combustion of Solid Fuel—Rocking Gates, &c.—Liquid and Pulverised Fuels. (*c*) Mechanical Stokers. (*d*) Smoke consumption: Spark Arresters." Report No. 1 comes from America, and was prepared by Mr. George H. Emerson, Chief of Motive Power and Equipment, Baltimore and Ohio Railroad.

The former practice of some half-a-dozen United States railways, operating in territory adjacent to the anthracite coalfields, of using anthracite coal for locomotive fuel has, within the last ten years, been abandoned on account of the steadily mounting cost of that variety of coal, caused by the limited supply available, and the demand for it as fuel for heating purposes in residences and buildings in cities along the Atlantic seaboard. The coal at present used in America is almost exclusively bituminous coal of high rank, with a calorific value of 13,000 to 15,000 B.Th.U. per lb., and with volatiles between 15 and 40 per cent. The practice of mixing a proportion of low-grade coal with a better grade, in order to compensate for the high cost of the latter, is not followed to an appreciable extent in the United States. The substitution of low rank coals for bituminous fuel introduces a number of problems of operation. Because of the generally lower heat value and the difficulty of realising that value in the fire-box, it is obvious that a much larger quantity of coal must be burned in a given time in order to develop the required horse-power. For that reason the grate area must be larger—one authority says 50 per cent. larger—than would be required for good bituminous coal. Results show that the better of the low rank fuels can be used, and, in fact, they are to-day being used, on those divisions of the lines on which length of haul of bituminous coal makes its use too expensive or otherwise inadvisable. The use of oil, however, has so many advantages that it will usually displace any solid fuel whenever the price is low enough to keep the fuel item in operating expenses near to what it would be with coal. The use of pulverised fuel is making no progress.

On the score of availability in adequate quantity and at an average cost which is not prohibitive, oil fuel outranks all competitors in some extensive sections of the United States and competes on even terms in others. A paper read before the 1923 Convention of the International Railway Fuel Association said that on the basis of theoretical heat units, 1 ton of fuel oil is approximately equal to 1.46 ton of coal, but, on the basis of actual operation, 1 ton of fuel oil is more nearly equal to 1.79 ton of coal. Considering these figures with respect to tonnage hauled, it means a saving of 44 per cent., provided the haul on fuel oil is approximately the same as on coal.

The development of the mechanical stoker permits the handling of more tonnage at higher sustained speed, and with greater average dependability than would be practicable with hand stoking. It is generally considered that a tractive capacity of 50,000 lb. or a coal consumption of 4000 lb. per hour will justify the use of a mechanical stoker.

The reporter for the British Empire on Subject IV. A is Mr. C. B. Collett, the chief mechanical engineer of the Great Western Railway. After dealing with coal as a fuel, it is observed that briquettes have only been used during periods of labour troubles, which caused a shortage in the coal supply. When used, the firemen and coalmen complained of dust affecting their eyes and skin. Steaming was found to be satisfactory when briquettes were used alone or mixed with coal. No alteration is necessary in the construction of coal-burning grates when briquettes are used. Oil fuel has, for the most part, been tried experimentally only, or as a temporary expedient during miners' strikes. It is not likely to be a commercial proposition where coal is reasonably available. It is, however, being used on 156 engines on the Karachi section of the North-Western Railway in India, the calorific value being 18,450 B.Th.U. Smokeless combustion can be ensured with correct adjustments. Tests made on that railway give the relative efficiencies of coal and oil as 56.5 per cent. and 100 per cent. The regular use of oil does not lead to more failures than are likely to occur with coal, and engines are called upon to handle 10 per cent. greater loads than similar engines using coal. Only one railway—the southern area of the London and North-Eastern—reports having used pulverised or colloidal fuel. Both these fuels are stated to be less reliable and less efficient commercially than either coal or oil, and as being more expensive, in Great Britain, than ordinary coal, but not much more so than oil. The use for locomotive purposes of peat or lignite has not been reported.

After discussing fire-bars, rocking grates and mechanical stokers, Mr. Collett comes to smoke emission. He says that to reduce it under firing conditions, a curved deflector plate is fitted in the fire-box opening, thus causing an effective admixture of air with the gases. Notwithstanding the adoption of these devices, it has not been reported that it is found practicable to use lower-grade coals. Smoke emission, when fresh fires are lighted, has not developed any special device for its prevention. The general practice is to actuate the usual steam blower, although in one case—on the southern area of the London and North-Eastern Railway—a subsidiary blower, actuated by compressed air, may be brought into use.

Several companies have adopted spark arresters in the smoke-box that do not impede the draught, and in some cases a beneficial effect on the fire is obtained, but in other instances such advantages have not been reported. Generally speaking, no variation in blast pipe orifice is necessitated when spark arresters are used, but in one or two cases it has been possible to enlarge the orifice a little. In general, the plates are arranged for the dual function of spark arresting and draught deflecting by inducing the flue gases to pass more freely through the bottom section of tubes. The effect of well-designed spark arresters is to equalise the smoke-box vacuum at the top and bottom rows of tubes, and has resulted in improved steaming and combustion. To facilitate quick removal of the plates, they are made in sections, with fulcrum brackets resting on suitable supports and interlocked by automatic hand levers into fixed brackets. Arrester plates on smoke-box doors are very limited in their application, only the southern area of the London and North-Eastern reporting on their employment. Inefficient draughting arrangements eject a large percentage of ash from the chimney.

The report from other countries than America and the British Empire was written by MM. Chenu (Belgian State Railway) and Tete (P.L.M. Railway) jointly

The full title for the second part of the question of reducing the cost of traction is:—"Lubrication of Axle-boxes for all Rolling Stock: (*a*) Axle-boxes, Plain Bearings, Roller and Ball Bearings; (*b*) Lubricants." Mr. Emerson is again the reporter for America. Plain bearings, with an underfeed of oil, are used almost exclusively for passenger and freight cars and locomotive tenders. Roller bearings have been experimented with by several railways, but enough has not yet been learned about them to justify serious consideration of their adoption generally. The first cost is very high, and until it can be considerably lowered, it almost precludes the possibility of their employment. Considerable trouble has been experienced with their breaking in service on heavy cars.

The field of mechanical lubrication is quite broad, and the explorations into the subject are still in their infancy. Several devices have been developed, but none have been found entirely successful and reliable enough to warrant their adoption generally. A large number of railways purchase their lubricants under guarantee contract systems from various oil companies, which guarantee that the performance shall be such that it will not cost more than a certain figure to lubricate locomotives and tenders per 1000 miles run. Another figure is given for freight cars and for passenger cars. Should those figures be exceeded, the oil company loses the amount required over the guaranteed cost. The oil companies furnish one or more service engineers to look after their products, and the railway company agrees to co-operate with these engineers and to eliminate waste as much as possible. Under such a system, lubricating oils and greases are not purchased under specification by the railway companies.

Report No. 3, as to lubrication practice in the British

Empire, was drawn up by Sir Henry Fowler, deputy chief mechanical engineer, London, Midland and Scottish Railway. Sir Henry remarks that although the necessity for adequate lubrication of the bearings of locomotives, carriages, and wagons has always been recognised, the subject is one which, until late years, appears to have received less attention than any other branch of rolling stock engineering. It is now realised that by careful design of the axle-box, in conjunction with the method of lubrication, economies may be effected as follows:—(1) Reductions in delay and dislocation of traffic by heated bearings; (2) reduction in wear of bearings and, hence, of maintenance costs; (3) reduction and, therefore, saving in oil consumption; (4) reduction of train resistance and, therefore, cost of traction. The inevitable result of the development in design of the locomotive has been greater bearing pressures and peripheral speeds at the journals, which cause increased frictional resistance, wear and less reliability. The design and lubrication of axle-boxes for railway rolling stock are essentially peculiar to themselves, owing to the conditions under which they run. In the first place, the axles have to start rotating from rest under their full load, and, secondly, the magnitude of the load on any bearing and its direction are not constant. When the journal is at rest or moving very slowly the oil film is broken or not formed completely. As a consequence there is solid contact between the metal of the journal and the metal of the axle-box brass, and that condition continues until the speed reaches such a value that the oil film can be formed and maintained. It is therefore necessary to provide a bearing of some metal whose anti-friction properties on the journal tend to reduce seizing to a minimum. At the same time, however, the bearing metal must not be so soft that it deforms under the considerable load it may have to carry, and in many cases under the hammering action it may be subjected to by reversal of stress. If, however, the direction of the load is variable—as in the coupled wheel bearings of wheels which are braked intermittently—the arc of contact of the bearing should not be made too small or it will be insufficient to take the resultant thrust.

Dealing with the axle-boxes of locomotives and tenders, the report says that with the development of steel castings the majority of administrations appear to have adopted that material for axle-boxes for the coupled, bogie and truck wheels as standard practice. The reduction in the cost of producing and machining for a steel casting is in its favour as compared with a forged axle-box, but both types have to be fitted with a separate brass and, consequently, have the disadvantages of discontinuity of heat conductivity and low scrapping value. A notable exception is found in the bogie axle-box of the New Zealand Government Railways, in which the brass is cast in the box, which is a steel casting. Some of the modern examples show a reversion to the solid type made of non-ferrous alloys with white metal pockets. Thus, the Southern Railway uses coupled and bogie axle-boxes of manganese bronze (brass); the London, Midland and Scottish also has manganese bronze (brass) coupled boxes; but the London and North-Eastern uses solid brass axle-boxes for the coupled and bogie wheels.

The adoption of dust shields for preventing grit, &c., getting to the bearings does not seem to be general practice. For tender axle-boxes, however, dust shields are almost invariably fitted and the outside bearing axle-boxes in question are designed with a separate compartment on the inside facing to house the dust shield, which in most cases is arranged to surround the collar on the journal between the face of the axle-box and the wheel boss.

There are three general methods of supplying oil to the journal—from a reservoir provided in the axle-box crown, from an auxiliary oil box, by an oil pad from a reservoir in the underkeep or in a separate oil-tray at the bottom of a closed box. In some cases a combination of top and bottom feed is used. For axle-boxes of coupled wheels top feed is universal, and in some instances a combination of top feed from the axle-box reservoir and the auxiliary oil box is used. For bogie and truck boxes top feed from an axle-box reservoir or underfeed from a keep is most usual. An auxiliary box in that case may necessitate a flexible pipe if it is to be accessible. Tender boxes are almost invariably of the underfeed type.

The equipment for mechanical lubrication consists essentially of a mechanically operated lubricator, driven by suitable gear coupled to the engine motion. The lubricator consists of an oil reservoir of fairly large capacity, and contains a series of small pumps which are operated by the movement of the ratchet wheel or friction clutch to which is attached a lever to couple to the driving gear. Generally the engines which have been equipped with mechanical lubricators are heavy goods and passenger, and in the majority of cases that type of lubrication has been confined to the axle-boxes of the coupled wheels. With the administrations which have given particulars the cost of fitting varies from 136 to 500 per cent. and the cost of maintenance from 5 to 225 per cent. more for mechanical than for trimming feed lubricators. The percentage saving in the oil consumption, as reported by five of the administrations, varies between 12 and 50 per cent. None of the administrations reporting have fitted or experimented with roller or ball bearings on locomotive axle-boxes.

The most modern type of axle-box for coaching stock is of the outside bearing type with an open front. The box body is either of cast iron or cast steel with a separate brass. It appears to be the universal practice to fit dust shields to coaching stock axle-boxes. The administrations of Great Britain have not adopted the cast steel box to any great extent, but the London and North-Eastern has a small proportion of such boxes. The Southern Railway has wrought iron boxes under trial. All administrations have adopted the underfeed method of oil feed. The London and North-Eastern and the London, Midland and Scottish have used Skefko roller bearings. The former reports that no trouble has been experienced in service and no apparent end wear has taken place after running 31,000 miles. The latter company says that whilst there is a variation in resistance in favour of roller bearings it disappears, and that no saving has been obtained in coal consumption per ton-mile by the adoption of roller bearings. Mineral oil is the lubricant used. The cost of fitting the roller bearings on the L.M.S. Railway is £22, as compared with £4 for plain bearings. No trouble has been experienced with these roller bearings, and so far as end wear is concerned they have proved efficient up to date.

For wagons, as with coaching stock, the open-fronted type is the most widely used. Dust shields are fitted in most cases. Mineral oil is now most generally used for lubrication. It is underfed, in conjunction with cotton or wool waste packing or with spring oil pads. None of the administrations report that they have experimented with or adopted roller or ball bearings for wagon stock.

Sir Henry's report is accompanied by ten tables, which give particulars of the practice in these matters on the four grouped British railways, five Irish and thirteen overseas railways, together with three drawings of the axle-boxes of locomotives, one of those of a tender, three of those of coaches, and one of a wagon axle-box.

Chemistry of Steel Making.

THE joint meeting of the Faraday Society and the Iron and Steel Institute, which was held under the presidency of Sir Robert Hadfield at the Institution of Civil Engineers on June 11th was the outcome of a recommendation from the Mining and Metallurgical Congress which was held at Wembley last year. A representative attendance was secured, and a number of contributions dealing with various aspects of the physical chemistry of steel-making processes, written by recognised authorities, were submitted. It was pointed out at the Wembley Conference that this was a subject on which more definite knowledge was essential.

Sir Robert Hadfield, in opening the proceedings, referred to the need for such a gathering, and said he had brought together some specimens which he had acquired, and which to some extent, though quite inadequately, reflected the history and progress of steel making. It seemed to be highly desirable to have an adequate portrayal of the history of steel manufacture by means of historical specimens in the form of a national exhibit, on the lines of the excellent collection devoted to engineering in the Science Museum at South Kensington, in view both of the importance of the steel industry and of the more complete knowledge to be obtained from a review of past progress. There were doubtless many and valuable items in the possession of various steel firms and individuals, who would be willing to hand them over for such a purpose, and from these and other sources, including the Iron and Steel Institute, it was probable a collection of the highest historical and practical interest and value could be formed. Such a collection, too, seemed all the more justified when it was realised to what extent modern engineering progress, so well represented by the collection at South Kensington, was dependent upon collateral progress in the manufacture of materials, and particularly that of steel.

The exhibits of old work included an iron cramp from the tomb of Cyrus, founder of the Persian Empire, chippings from the ancient pillar of Delhi, specimens of Singhalese iron and steel, and nails and bolts from a Viking ship of the eighth century. A later stage of development was represented by samples of American pig iron made in 1734, sheet iron from the original gasometer of Murdoch, specimens of wrought iron rails, and cast iron switches and crossings used on the early English railways, and specimens of the earliest crucible steel made by Huntsman. Exhibits of a more modern era comprised specimens of some of the original articles made in manganese steel, alloy steels, stampings of silicon steel, tested specimens of high-tenacity steel, heat-resisting steels, and non-corrodible steels. The latest development in electrical melting, including bombardment by X-rays, were illustrated as well as the use of the petrological microscope for the scientific control of steel-making materials and processes. The books shown were inspected with much interest. Noteworthy volumes were the Liber Mineralium of Albertus, dated 1505, and Agricola's De re Metallica, first published in 1556, and containing reference to a process for making steel.

In a general review of the subject, Sir Robert Hadfield said that just as the genius of Sir William Siemens put into the hands of the metallurgist a new weapon of powerful utility, the regenerative furnace, so in the course of the last two decades there had been developed in an almost unobtrusive manner an appliance that would probably prove to be almost as potent, namely, the electric furnace. During this time there had also arisen what might almost be described as a new age in metallurgy, that of the alloy steel, and the rapid strides made had been in a measure due to many series of systematic researches and the better understanding of a domain of science that was governed by the laws of physical chemistry. This new field of progress was most important; by the development of the use of alloy steels the engineer had been provided with material permitting progress in design and utility hitherto undreamt of. To give instances—there was the wide adaptability of the nickel chromium steels, by means of which under suitable heat treatment almost any desired degree of strength and ductility might be obtained; manganese steel with its extraordinary toughness and extremely high wearing properties; the magnetic value of silicon steel; and, lastly, the more recent appearance of many valuable non-corrodible acid-resisting and non-scaling steels, some of which retained their strength at high temperatures. In the manufacture of these steels new problems were opened up for the steel maker and a much more complicated set of reactions took place than with ordinary carbon steels. The basic reactions of steel manufacture depended upon some chemical reaction of oxidation, reduction, or some reversible displacement in a somewhat viscous liquid phase, and the resulting changes were largely influenced by temperature conditions, and fell into a class of chemical changes governed by thermodynamical laws. To such an extent, however, had advance been made in the study of the *rationale* of the free energy of chemical reactions, and the significance of the equilibrium constant, that there were now definite means known for attacking from a purely theoretical basis the fundamental reactions in question.

There remained one serious disability to the successful prosecution of the task, and that was a lack of the essential physical data at high temperatures, specific heats, heats of reaction, equilibrium constants, the determination of which involved difficult and extensive experiment requiring a high order of skill. It was to the pure scientist that the steel maker must look for the determination of these needed constants. Another factor in steel manufacture of high importance was the physical condition of the molten steel. Consideration must also be given to the fuel and refractory materials used. The future development of all classes of steel-making processes must depend in some measure upon refractory material research, since the present temperature limits were governed by the properties of the materials used in the furnace structure. The same limits must also influence the possible use of oxygen which had been shown, on purely theoretical grounds, to have certain advantages. These subjects alone were fields representing great possibilities in the future.

Cognate studies which were of much interest to the steel maker were the constitution of the binary, ternary and quaternary alloy systems. These systems opened up a field of future discoveries in which systematic study of the simpler combinations might be a prelude to the possible production of new types of steel. Work of that kind had been undertaken by the Ferrous Alloys Research Committee of the Institution of Mechanical Engineers, amongst the projected studies being that of the constitution and physical properties of the binary alloys of iron in the absence of carbon. With the aid of Dr. W. Rosenhain, a beginning had been made at the National Physical Laboratory with the iron-oxygen system. The effect of oxygen in steel still remained one of the most important problems facing the metallurgist. One of the chief difficulties in carrying out these high-temperature researches on materials of special purity was the construction of a furnace of suitable type and materials of adequate refractoriness to prevent contamination of the melt with impurities from the furnace linings. These studies of the influence of oxygen also opened up the question of the future possible use of the vacuum furnace. The design and construction of a furnace suitable for special work of that kind had been a need for some time past. Some progress towards the solution of the problem had, however, been made during the last few years by the appearance of the high-frequency induction furnace.

Other subjects for research were:—The study of the equilibria of slag reactions, which were the key to the reactions in the steel; the mechanism of the origin of slag inclusions in steel, and means for their elimination; the reactions between molten metals and the refractory materials constituting the hearth and banks of furnaces, and the conditions of penetration of combined and "adsorbed" oxides; the study of the physical properties of slag at high temperatures; viscosity, fluidity, surface tension; and a study of the mode of the cooling of ingots, which would throw light on the problem of segregation, and the physical properties of the segregates.

RE-ACTIONS IN STEEL MANUFACTURE.

In a review of the balance reactions in steel manu-

facture, Dr. A. M'Cance put forward for consideration groups of equations. He said that the existing data concerning the reactions between iron oxides and carbon oxide gases and hydrogen were so incomplete that serious discrepancies arose in making deductions, and it was obvious that until concordance was attained among the fundamental data, any extensions would give results quite uselessly divergent. It was necessary therefore to determine the course of the main reactions at ordinary temperatures accurately, before they could be extended to higher temperatures, as the determination of the necessary data at the elevated temperatures would be exceedingly difficult and probably highly inaccurate. A certain number of experimental researches on the iron oxide equilibria had already been carried out, notably by Schenck and his co-workers, but, on examining these results in detail, serious discrepancies became evident, which showed that the equilibrium constants determined did not in some instances refer to the equation under examination, but to some other. Since it was possible with equilibrium equations to deduce related equations by means of intermediate reactions already known, that placed in the hands of the research worker another valuable means of checking experimental determinations. On applying it to the iron oxide reactions, grave discrepancies were apparent. He (Dr. M'Cance) then concluded that a complete experimental determination of those reactions was essential, but, unfortunately, other duties prevented him from carrying out that intention. In order to make some progress, however, it was thought that by choosing some probable course for one of those reactions, it would be possible to calculate a group, and then by interchecking the members of such a group to evaluate the unknown constants by a process of trial and error, until they were all mutually concordant among themselves. While somewhat tedious—it had taken approximately nine years to arrive at a satisfactory solution—it had the great merit that it could be carried on under conditions which made experimental work impossible. It was also satisfactory to state that recent experimental determinations which had been published agreed well with the curves determined in that manner. Dealing with the deoxidation of liquid steel, Dr. M'Cance said he was satisfied that oxides of iron were soluble in both solid and liquid steel, and that was an important conclusion, since corroborated and confirmed by the brilliant work of Rosenhain and Hanson. With regard to the relative deoxidising power of manganese and silicon, with degrees of oxidation appropriate to the temperature of 80 and 85 per cent., the theoretical values were in accordance with that found experimentally by Brinell. The most economical method of using alumina as a deoxidising agent was as a low grade alloy, containing probably only 5–10 per cent. of the metal. With regard to the influence of deoxidisers on gases, it could be accepted that alumina, silicon and manganese would reduce CO_2 at steel-making temperatures, but that only alumina would reduce CO appreciably. Silicon and manganese would only reduce a very small percentage of that gas dissolved in steel, and that percentage decreased with increasing temperatures.

Mr. T. P. Colclough dealt with the reactions of the basic open-hearth furnace. He gave figures derived from ordinary working conditions at the Park Gate Iron and Steel Company's plant to illustrate his points. He showed the important nature of the oxidation due to the gases of the furnace atmosphere. The relative rates of oxidation of carbon and phosphorus were shown to depend primarily on the basicity of the slag, and the stages at which mass and thermochemical considerations come into action were indicated. A study of the manganese and ferrous oxide reaction was also given; a value of 10.1×10^{-4} was suggested for the equilibrium constant of that reaction; and the bearing of the reaction on the distribution of manganese between the slag and metal, and the problem of deoxidation, was discussed. Data were given to show the close parallelism between the distribution of manganese and the process of desulphurisation; the conditions for the removal of sulphur were discussed. Data were quoted to support the view that in certain slags there was the probability of the formation of a compound of lime and ferric oxide-calcium ferrite.

A paper was contributed by Mr. Alexander L. Field (New York) on "Physico-Chemical Phenomena from Melt to Ingot." It was pointed out that in the course of a research on the effects of zirconium on steel, the need for a workable physico-chemical theory which would explain the efficacy and diversity of function of that new steel-making element became apparent. In this contribution such a theory is developed and its general applicability to deoxidation and degasification by manganese and silicon revealed. It was a necessary and expedient step in development of theory to apply to the progressive phenomena of oxidation in the hearth of the open-hearth furnace certain well-established principles of chemical kinetics. Differential equations were obtained, the solution of which followed from the theory of maxima. Solution of those equations yielded values for certain important equilibrium and solubility relationships, which were sufficient not only to fix the composition of the metal bath at any given time with respect to carbon, magnanese, silicon, FeO, and CO, but also to predict quantitatively the extent to which furnace or ladle additions of ferro-manganese or ferro-silicon or both decreased the percentage of dissolved FeO and CO. Values were also derived for the limiting composition of basic open-hearth steel, and for the minimum additions of manganese and silicon which accomplish deoxidation in steels of various initial compositions. Only the basic open-hearth process was considered in detail, although many of the equations derived and conclusions reached were regarded as of general application.

Mr. F. W. Harbord, who opened the discussion on this group of papers, directed attention to the importance of having manganese in the slag, especially during finishing operations, in order to ensure the presence of a reasonable percentage of manganese in the metal. The realisation of that condition had an enormous effect on the physical properties of the steel. The mathematical conception put forward was welcome from the point of view of obtaining a working hypothesis, and might prove of real practical value.

Dr. W. H. Hatfield expressed the opinion that the contributions under discussion dealt with the subject of furnace reactions in a manner which had not been attempted on any previous occasion. Hitherto much had depended on the skill of the worker who had to a great extent redressed the lack of exact knowledge of the reactions. There was a lamentable lack of physical data at high temperatures, which he hoped would be removed in the near future. Dr. M'Cance had handled a complex subject in an admirable way, but it was necessary for him to give a clearer definition of deoxidation, as the basis of his mathematical treatment depended on his interpretation of that process. He was surprised that Dr. M'Cance had not referred to the effect of hydrogen. With regard to the heterogenity of iron and steel, it would be within the knowledge of most of those present that a Committee of the Iron and Steel Institute was investigating that subject. The importance of the work had led to the industry putting the Committee in possession of a great deal of information which had cost a large sum of money. The report of that Committee, which should be ready next year, would deal with the degree of heterogeneity to be obtained in ingot masses of steel up to 100 tons and over. He was glad to have from Dr. M'Cance a confirmation of his own opinion that FeO was soluble in liquid steel. That was a fundamental point as affecting the reliability of large ingots and forgings under onerous service conditions. Dr. Hatfield showed a slide dealing with the history of a charge for the acid open-hearth furnace. It represented ideal conditions of working, as at the right stage of the process both manganese and silicon were re-entering the bath from the slag. There were two points on which further information from Dr. M'Cance would, he said, be welcomed. One was the apparently rapid drop of the carbon content in open-hearth steel at a particular point; the other that at very high temperatures the charge became super-saturated with gases, and did not yield to the treatment mentioned in the paper.

Dr. W. Rosenhain referred to the question of the solubility of gases in steel and their effect on the melt. The hydrogen content of steel, which was very large, was not exactly a reaction product, as it was probably absorbed from the furnace atmosphere. Slag questions were very important, but until recently there had not been a refractory material available which would withstand the temperature of molten iron oxide. That difficulty had been overcome. It had been shown by recent work that the last trace of oxide could be removed from molten iron. A great deal more work on the whole subject under discussion was required. If, as Dr. M'Cance had endeavoured to show, it was possible to get fundamental ideas on the trend of furnace reactions, it would put those who were investigating the problems experimentally on the right track.

Mr. Service, giving the results of his own work, indicated the relation between the degree of deoxidation and the production of sound steel.

Mr. Whiteley expressed an opinion that the oxide penetrated along the boundaries of the crystals, and got into the mass of the material owing to the shifting of the boundaries. Many of the troubles referred to by Mr. Colclough would vanish if he could discover a catalyst which would hasten up the furnace reactions.

Mr. Colclough said that all steel makers were concerned with the action of silicon and manganese, and it would be interesting if Dr. M'Cance could state what would be the effect of the combination of those two ingredients.

Dr. M'Cance agreed that hydrogen did not enter into the reactions of the furnace, and he had not dealt with its presence, which was a subject for independent experiment. Reference had been made to the extent of deoxidation on the quality of the steel, and he had reached the conclusion that from 80 to 85 per cent. was the border line between sound and unsound steel. Mr. Whiteley's suggestion that the oxide penetrated along the grain boundaries was probably correct.

SLAG PROBLEMS.

Mr. Peter M. Macrair made a contribution on slag-lining equilibrium. He said the changes in the acid open-hearth furnace were the most obvious confirmation of the tendency to equilibrium between slag and lining. It would be admitted that for any definite temperature a ferruginous slag would become more viscous as the SiO_2 content increased above 40 per cent. A broad definition of what took place was that the slag tended to get more viscous owing to its contact with the lining, and that the "inactive" stage in steel-melting operations was set up by the increased viscosity of the slag causing a decreased rate of reaction. That was not necessarily a state of equilibrium. In acid practice the slag tended to absorb SiO_2 from the banks, or similarly alter in composition by reduction of FeO, till at about 60 per cent. SiO_2 for open-hearth temperatures it became viscous and inactive. That composition was practically independent of the amounts of CaO, FeO, MnO present. In basic slags the inactive stage was reached at about 60 per cent. CaO, 40 per cent. SiO_2, and low FeO, while with increasing amounts of FeO or MnO, the SiO_2 content diminished. The condition for stabilisation of P_2O_5 in the cinder was that the SiO_2 content was less than that required for the limiting slag of the same CaO FeO content.

The function of ferric oxide in acid and basic open-hearth slags was discussed by Mr. J. H. Whiteley. There could be little doubt, he said, that throughout the boiling period Fe_2O_3 acted constantly as a carrier of oxygen, since 50 per cent. of the carbon might be removed by gas oxidation in normal working. Accumulation of Fe_2O_3 and increase of iron in the slag were prevented at that stage, however, by the velocity of the carbon reaction, owing in part to the passage in and out of the slag during the boil of great numbers of minute metallic globules. The amount of metal then held in suspension might be as much as 5 per cent. by weight of the slag. There was evidence to show that if the oxidation of the carbon could be effected in a neutral atmosphere, with an iron silicate slag only the boiling period would be greatly lengthened. Thus gas oxidation by the agency of Fe_2O_3 accelerated the process, although it did not, like ore oxidation, improve the yield. In the basic process the same effects were observed to a still greater extent, notwithstanding the fact that the iron content of the slags might be as low or even lower than 6.0 per cent. During the refining period the ratio of Fe_2O_3 to FeO was invariably much higher than in the acid process.

The chemical reactions of the basic electric process were described in a contribution by Mr. Frank T. Sisco (Air Service, U.S. Army). The paper pointed out that in the basic electric process the scrap was melted under oxidising conditions that could be closely controlled. By regulating the amount of oxide used with the charge or added after melting was complete, all of the silicon was oxidised, and was held by the slag and a variable amount of manganese and carbon oxidised; the former went into the slag, the latter passed off as carbon monoxide gas. The control of those two elements depended upon the amount of oxide used, the character and composition of the scrap, and to a great measure on the skill of the furnaceman. By carefully controlling oxidation and regulating the temperature, most of the phosphorus was oxidised to phosphoric acid, and was held by the slag as calcium phosphate. After oxidation was completed the slag was removed and the metal recarburised, if necessary. The final process was the deoxidising and desulphurising of the metal by means of a very basic slag, which enabled complete desulphurisation to be accomplished.

ECONOMIES IN RAILWAY WORKING.

SECTION 58 (1) of the Railways Act, 1921, sanctions an annual net revenue equivalent to the aggregate net revenues of the year 1913, provided that "efficient and economical working and management are exercised." The Railway Rates Tribunal has recently been engaged on that point and some interesting evidence has been given. For the London and North-Eastern it was stated that its economies up to June 30th, 1924, were £325,000. They came mainly from savings in salaries, the result of officers and servants being dispensed with owing to re-organisation rendered possible by amalgamation. Where posts had become redundant but their occupants had not been permanently disposed of, the salaries of those posts were not treated as economies. Other steps had been taken which would result in economies in the construction and repair of locomotives, carriages and wagons, and in relation to train working. Those could only be realised by a gradual process, but they were believed by their expert officers to be very substantial in character. For the London, Midland and Scottish Railway it was said that savings would be effected by bulk purchases and very definite steps had been taken towards economies in construction and in train working by concentration and reorganisation, but a figure could not be put upon the realised savings. It was said that by the introduction of 20-ton wagons the Great Western had saved £94,350 in capital expenditure on sidings, and a saving of £20,000 per annum on shunting, haulage, &c. The Southern Railway saved £64,000 in stores and £44,000 in printing and stationery. On that line two general managers, several assistant general managers and between sixty and seventy clerks had been dispensed with. It was subsequently agreed between the parties that the economies should be placed at £1,200,000, and that they were entitled to an allowance of one-third, divided thus:—London and North-Eastern, £91,000; London, Midland and Scottish, £139,000; Great Western, £93,000; and Southern, £77,000.

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and
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No. VI.—GERMANY (*continued*).*

5. Results of Electrification.

(*a*) *Comparison of Costs.*—The following figures (Tables IV. and V.) compare the annual costs of steam and electric operation under the same conditions for four different sections of the German Federal Railways. Although some of the expenditure is estimated, it has been carefully worked out and may be taken as a true statement under the ruling conditions. For steam working the rate of interest for steam locomotives and communication lines is taken at the low figure of 5 per cent.

TABLE IV.—*German Federal Railways: Comparison of Steam and Electric Working, Annual Running Costs. Gold Marks.*

Item.	Line	Halle–Leipzig–Magdeburg, including estimates for Halle–Cöthen–Magdeburg.		Silesian Mountain Railways.		Overall estimate for Bavarian lines running and under construction.		Estimate for main-line Brockau–Breslau–Liegnitz–Arnsdorf (Silesia).	
	Source of power for electrical generation	Lignite coal.		Cheap waste coal.		Water.		Bituminous waste coal in coking plant.	
	Date	March, 1923.		March, 1924.		January, 1924.		January, 1924.	
	Type of operation	Steam.	Electric.	Steam.	Electric.	Steam.	Electric.	Steam.	Electric.
1. Tractive energy (bituminous coal for steam operation; energy at power station for electric operation)		3,075,200	1,190,000	3,125,000	1,120,000	11,054,250	2,627,000	3,737,535	1,666,000
2. Lubrication		30,500	24,700	21,000	20,000	92,320	60,850	15,362	15,456
3. Locomotive water		33,200	—	130,000	—	114,000	—	367,500	—
4. Locomotive maintenance and repair shops		2,000,000	1,240,000	1,000,000	1,000,000	6,740,000	4,178,800	1,278,900	1,095,000
5. Locomotive crews		349,100	251,300	800,000	498,000	2,143,020	1,632,900	956,700	483,000
6. Supervision and maintenance of sub-station feeders, line conductors, telegraph and telephone wires and iron bridges		56,200	167,600	83,000	194,000	225,000	470,000	16,400	22,550
7. Train heating (included in items 1 and 3 for steam operation)		—	95,500	—	33,000	1,129,000*	210,000*	—	34,335
7*a*. Lighting and power supply to Halle railway station		164,000	88,600	—	—	—	—	—	—
8. Renewal fund for plant and locomotives		676,600	836,800	465,000	1,186,000	1,336,940	1,908,560	642,216	550,670
8*a*. Revenue from sale of by-products		—	—	—	—	—	—	—	1,168,430
9. Interest (telegraph and telephone lines and locomotives, steam operation)		547,000	—	425,000	—	2,482,500	—	1,228,325	—
10. Amount set out to balance up the running costs; this is available for interest on capital expenditure for electric plant and locomotives		—	3,037,300	—	1,998,000	—	14,228,920	—	5,544,357
Total, gold marks		6,931,800	6,931,800	6,049,000	6,049,000	25,317,030	25,317,030	8,242,938	8,242,938
Capital expenditure on electrification (estimated)		46,300,000		18,900,000		155,100,000		40,161,000	
Interest on capital represented by item 10		6.6 per cent.		10.6 per cent.		9.2 per cent.		13.8 per cent.	

* Lighting and power supply (excluding traction) for railway purposes.

TABLE V.—*Showing Interest on Capital Spent or to be Spent on Main-line Electrification.*

Section.	Average power per annum, kWh per route kilom.	Interest on capital outlay.
Halle–Magdeburg lines	209,000	6.6
Silesian Mountain railway	200,800	10.6
Bavarian lines	126,800	9.2
Silesian main line (Breslau–Arnsdorf)	700,000	13.8

(*b*) *Possible Future Economies.*—It is expected that future working will show appreciable economy in various items as the electrified schemes become bigger and more unified. As yet electric haulage has been applied to routes with only moderate traffic, *i.e.*, where it cannot show to the greatest advantage. Further, electric locomotives have been costly, being as much as two and a-half times the price of steam locomotives of equal weight. When ordered in numbers, however, the cost will fall to 1.8, or perhaps 1.5 times the price of steam locomotives. These considerations led to the standardisation of six types of electric locomotives (see Section 6). As soon as sufficient locomotives for complete services are available they will be much better utilised than with the present mixed traffic, and it is estimated that in some cases the number of electric locomotives will be only 75 to 80 per cent. of the number of steam locomotives.

As there are fifteen different experimental types in the Breslau and Leipzig districts, it has not been customary to stock spare parts, although it is being done with the new standard types. Further, repair shops are not yet built and equipped, so that the railways have not been able to carry out their own repairs. Time and money are also needed to train the *personnel* for the altered conditions.

The limited extent of the electrified networks and the age of the generating stations has led to inefficient coal consumption. Future improvements in the use of pulverised coal and thermal storage will considerably increase the power station efficiencies. Even under the present unfavourable conditions, however, the example of the Mittelsteine station can be quoted; this power-house supplies the Silesian mountain railways and uses but 60 per cent. of the coal which would be necessary were steam traction employed. Its consumption is at present 8700 kilogram-calories per kilowatt-hour (= 34,200 B.Th.U. per kilowatt-hour), which figure will be decreased to about 8200 (= 32,400) when the whole of the traffic is worked electrically. A modern power station would have a consumption of about 6000 kilogram-calories (= 24,000 B.Th.U.) per kilowatt-hour.

(*c*) *Interference with Communication Circuits.*—It is considered possible to reduce the interference on the telegraph and telephone lines by the traction current to such a degree that communication is not impeded. The Federal Railways Department has not given great attention to the introduction of new apparatus such as milking transformers and the like, but has concentrated on the improved design of the generators and motors so that harmonics are as far as possible eliminated; alternators have been designed with suitable pole shoes, skewed slots, &c.; while the number of slots has been chosen to obviate ripples due to this cause. The alterations to the weak-current circuits have in general consisted of:—

(*a*) The removal of public communication overhead lines running beside the tracks.

(*b*) The use of cables for railway telegraph, telephone, and block signalling circuits, with twin stranded cores of equal capacity to earth and a lead sheathing to conduct induced currents.

(*c*) The connection of long communication lines to an electrified section through well-insulated transformers.

(*d*) The use of "symmetrical connection" for telegraph lines for permanent current operation, *i.e.*, series relays are connected with one-half of the relay winding and battery in each branch. Where such telegraph lines are continued beyond an electrified section a relay is inserted.

It has been found unnecessary to employ track bonding, although the presence of the joints may increase the inductive pressures by 30 to 35 per cent.

(*d*) *Collective Results on the Silesian Mountain Railways.*—While the number of locomotives in 1921 was increased by 22 per cent., the traffic in ton-kilometres was 155 per cent. greater than in the previous year. The fact that the Mittelsteine station used (in December, 1921) only 60 per cent. of the coal which would have been necessary to provide the same service by steam traction has already been mentioned, and since in well-loaded traction generating stations a still lower consumption can be obtained, greater improvements in coal economy can be expected.

TABLE VI.—*Energy Consumption at Power Station Bus-bars Silesian Mountain Lines, Year 1921.*

Month.	Consumption. Watt-hours per ton-kilometre.
April	23.0
May	23.5
June	25.5
July	21.5
August	23.8
September	23.3
October	24.1
November	26.7
December	26.2

The transmission lines have not proved so satisfactory. In the design too little account was taken of the severe climatic conditions in the Riesengebirge. Violent storms of long duration are common. It has been found that there must be two independent transmission lines to ensure uninterrupted working. Electrically, however, the lines are satisfactory; short circuits seldom occur, and earth faults are limited in the usual way. Owing to the low frequency, interference with communication circuits is very small. The 110-kilovolt lines will in future be carried parallel to and about 50 m. away from the track, as a straight cross-country route from sub-station to sub-station makes maintenance difficult in winter.

The overhead contact lines have given good service. At times the storms have moved the wire laterally so that the collector bow has come off and broken the wire. In consequence the distance between the supports will be reduced in further extensions. The single

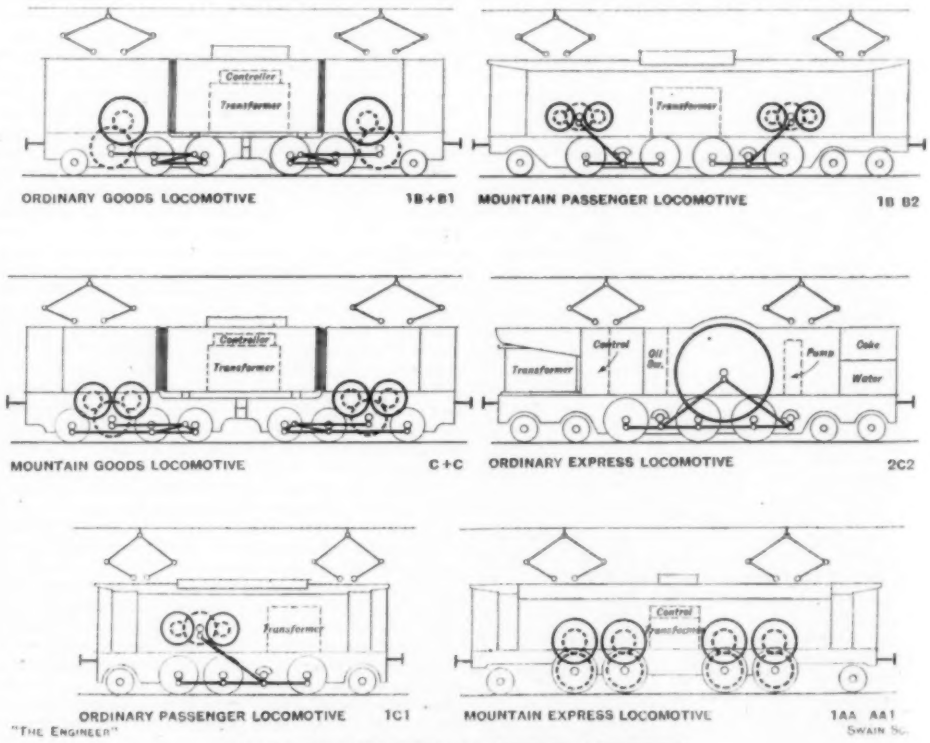

FIG. 7—STANDARD TYPES OF ELECTRIC LOCOMOTIVES

* No. V. appeared June 5th, 1925.

TABLE VII.—*German Federal Railways: Standard Electric Locomotives.*

Rolling stock: Locomotives.	Axles. Driving	Axles. Pony.	Type.	Weight. Total.	Weight. Adhes.	Weight. Elect. equip.	Weight. Axle.	Length over buffers.	Total wheel base.	Wheel dia. Driving	Wheel dia. Pony.	Motors.	No. of motors.	Connection of motors.	Motor voltage.	Loco. H.P. (cont.)	Tractive effort (1 hr.).	Speed (1 hr.).	Speed (max.).	Weight per H.P. (cont.)	Drive.	Gear ratio.	Speed regulation.	Current collectors.	No. of transformers	Cooling of transformers	Braking.
				t.	t.	t.	t.	m.	m.	m.	m.				v.	H.P.	kg.	km./h.	km./h.	kg.							
Ordinary goods	4	2	1 B + B 1	98	73.6	32	18	15.9	12.0	1.4	1.0	Single-phase neutralised series motors.	2	Parallel	392	1,600	17,000	30–59	65	61	Gears, jack shafts and coupling-rods	5.27	Contactors (electro-mag.)	Pneumatically controlled pantographs.	1	Oil	Air
Mountain goods	6	0	C + C	110	110	55	18	16.7	12.0	1.25	—		4	Two parallel groups	315	2,000	27,000	33–55	55	55		4.04	Some		1	Oil	Air
Ordinary passenger ..	3	2	1 C 1	81	55.2	26	18	11.5	8.6	1.4	1.0		2	Series	—	1,000	9,500	50–68	70	81	Gear, connecting-rod, jack shaft and coupling-rods	—	Sliding contact switch		1	Oil	Air
Mountain passenger ..	4	4	1 B B 2	116	73.6	56	18	16.2	12.75	1.4	1.0		4	Two parallel groups	315	2,000	16,500	54–82	90	58		2.86	Contactors, elect. mag. or electro-pneu.		1	Oil	Air
Ordinary express ..	3	4	2 C 2	112	55.2	44	18	15.7	12.4	1.6	1.0		1	—	384	1,200	13,000	66–99	110	94	Triangular frame	—	—		1	Oil	Air
Mountain express ..	4	2	1 A A A A 1	100	73.6	50	18	15.55	12.6	1.64	1.0		4	Parallel	—	2,000	—	—	100	50	Geared individual axle	—	Sliding contact switch		1	Oil	Air

catenary construction is used, and the new standard designs are arranged so that the view of the signals is not interrupted—a matter not sufficiently attended to in the past.

Despite prohibitive regulations, fatalities and other accidents have occurred through the *personnel* climbing on to tenders and carriage roofs. It has been decided to arrange the conductors 6.5 m. above rail level where possible. The supporting poles are of reinforced concrete and require no upkeep.

(*e*) *Energy Consumption.*—The energy consumption at the power station bus-bars (Mittelsteine) for the last nine months of 1921 are shown in Table VI.

6. Standard Types of Electric Locomotives.

Before the war the Prussian, Bavarian and Baden Railway Administrations experimented with twenty different types of locomotives in order to try out all possibilities. For normal services on the German railways the six types indicated in Fig. 7 and Table VII. will be required.* These have been standardised, use being made of the experience gained in the building, running and repairing of the experimental machines.

Motor Design.—It was comparatively easy to settle the motors and transformers. The neutralised series motor is now used almost universally, and the only differences which still exist arose from the practices of different firms. Some manufacturers employ resistance connectors between the armature winding and commutator; others do not. It is too early to demand a standard motor. Certain mechanical difficulties still remain, such as excessive brush friction loss at high speeds, which causes commutator heating when the current is off. Apparently when working a layer of gas reduces friction between brush and commutator.

Transformer Details.—Two types of transformer are in use—oil cooled and air cooled. From the original self-cooling oil type, where the weight of oil was considerable, the circulating oil type has been developed. A pump circulates the oil through the transformer and an air cooler. For passenger and express locomotives sufficient air cooling is obtained by placing the tubes through which the oil is pumped outside the locomotive. For slow-speed locomotives a fan blows air on to the cooler. While quite satisfactory, the oil is nevertheless an undesirable increase in weight. Although promising air-cooled types, in which moisture and dirt are kept away from the transformer, are available, too little experience is available for a definite conclusion to be reached as yet.

Control.—The speed is controlled by varying the voltage at the motor terminals by means of transformer tappings, the induction regulator having proved to be unsuitable. Two control systems worthy of note are the drum controller of Maffei-Schwartzkopff, and the sliding contact switch of Brown Boveri. The latter has recently been improved so that the power can be cut off rapidly in any position without auxiliary apparatus. For the present it has been decided to retain contactor controls for most of the locomotives, because their design has proved successful. The contactors may be operated electro-magnetically or electro-pneumatically.

Driving Mechanism.—The driving mechanism is the part offering most difficulties. The decision is that for speeds exceeding 50 kiloms. per hour the motors should not be nose-suspended, but that the whole weight should be spring-borne. The other extreme to the tram suspension drive is that in which the power is concentrated in a single motor mounted in the locomotive transmitting to the driving wheels solely through side rods. The great advantages of this construction are the accessibility of the motor and the small number of bearings. On the other hand, smaller motors are easier to handle in the repair shops.

Owing to the advantages of the pure side rod drive it has been decided to continue its use in the 2 C 2 express locomotives for normal lines (Fig. 7). All locomotives driving by side rods are provided with damping springs in the armature to prevent dangerous vibration. With regard to axle loading, the various German authorities have agreed to permit an axle load of 16 tons for locomotives when standing, with an addition of 15 per cent. for the effect of the centrifugal force due to unbalanced parts at the maximum speed. In the perfectly balanced electric locomotive there are no residual centrifugal forces, so that the permissible axle loading becomes 18.4 tons. This is the approximate axle loading for all the six types shown in Fig. 7.

With no centrifugal forces the speed of rotation can be increased up to the limits permitted by the lubrication and heating of the bearings—about 400 revolutions per minute. On the other hand, to utilise the motor fully a peripheral speed of 45 m. to 55 m. per second is necessary. Thus for a train speed of 75 kiloms. per hour the armature diameter must be 2.6 times the diameter of the driving wheels. This explains the large dimensions of the motor. Below 75 kiloms. per hour it becomes necessary to use motors running at higher speeds—*i.e.*, gearing becomes essential. This is no disadvantage, since gears can be made to have high efficiency and long life.

Geared drives are used in all the remaining five types. In the ordinary goods type (1 B + B 1) locomotive there are two articulated bogies with a motor on each, while the bridge joining the bogies carries the transformer, controller, switches and air pump. Replacing the two pony axles by driving axles and using four motors, the mountain goods locomotive (C + C) is obtained. The two pinions of a double motor drive a common gear wheel. Several parts of these two locomotives are interchangeable.

In the 1 B B 2 mountain passenger locomotive the double motors are mounted as high as possible to ensure smooth running. The 1 C 1 locomotives for ordinary passenger services is similar to the last, but only one double motor is required. In the two latter types the side rod is connected to a countershaft having its centre on a line with the centres of the driving axles. The two armatures of a double motor are in series, whereby a smaller current is required and a reverser for each pair of motors is saved.

The driving mechanism selected for the express locomotives for mountain service (1 A A A A 1) is the individual axle drive, due to Buchli, with which successful results have been obtained in Switzerland. Each driving axle has its own motor mounted above the axle. Both motor and gear wheel are fixed rigidly to the framework, but there is a flexible link work coupling between gear wheel and axle. It has been found that the locomotive weight is not increased by increasing the number of driving motors.

The revolving parts of the above constructions do not differ materially from those in steam locomotives.

Our thanks are due to Ministerialrat des Reichsverkehrsministeriums, W. Wechmann; to the late head of the Cabinet of the Prussian State Railways, Geheimrat Wittfeld, who, more than anyone, induced the Prussian State Railways to adopt electric traction for main lines, the great advantages of which he foresaw; and to the German electrical firms, such as the A.E.G., Siemens-Schuckert, and Bergman, for the information on which this article is based.

* The dimensions and axle arrangement are provisional only, and departures therefrom will be made as necessary.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE EXCHANGE LOCOMOTIVE TESTS.

SIR,—Since the *Great Western Railway Magazine* has published the results of the comparative tests of locomotives exchanged between the L. and N.E.R. and G.W.R., it may be permissible to refer to the tests as thus made public knowledge, by pointing out important mechanical features not remotely alluded to in articles so far dealing with the subject.

The large public which interests itself particularly in steam locomotives must be grateful to the G.W.R. and L. and N.E.R. for this early publication, for the figures as given were in all probability approved before publication by the two companies; and, except for recent frank publications by the G.W.R., it has been usual for companies to communicate very rarely information relating to locomotive tests.

A casual passenger behind both L. and N.E.R. and G.W.R. locomotives during the trials, I noticed, as a passenger, that riding behind the "Pacific" engine was more comfortable than behind the G.W. engine when on the steepest gradients—1/200—where the speeds were lowest, and when the jerking or pounding by the G.W. engine gave an unpleasant heaving or sagging motion to the cars, such as is felt also on the up gradient from Wellington to Whiteball summit—G.W.R.—and is quite common with starting trains on the Baker-street–Aylesbury section of the N.E.R., with both Metropolitan and Great Central locomotives. Either by reason of the great weight of the "Pacific" engine and tender, or the use of three cylinders, the L. and N.E.R. locomotive was much the easier engine for the passenger.

Lincolnshire folk who met my train—G.W.R. locomotive—appeared strongly impressed by the punctuality of the latter, and spoke depreciatively of the "Pacific," whose trains, they informed me, were almost invariably very late. As a stranger, I could offer no comment. From the figures published in the *Magazine* it is clear that the G.W. is the speedier and more economical engine, although the "Pacific" boiler, with its large grate, is, where weight is no object, usually found elsewhere the best for burning very hard lump coals. In the U.S.A. the large grate was specially introduced for burning anthracite in thin fires, which coal approaches Welsh for its heat intensity. It is not impossible that the N.E.R. boiler actually evaporated—when the N.E.R. fireman had become experienced with the enormous evaporative power of Welsh "best"—more water per pound of fuel than did the G.W.R. boiler, but the *Magazine* states that, even so, the N.E.R. boiler did not maintain its 180 lb. pressure. On the whole, it is clear that the N.E.R. engine used more steam for each effective horse-power hour than the G.W.R. engine.

Why the G.W.R. is more economical in steam is partly accounted for by a pressure one-fourth greater than 180 lb.—1197 B.Th.U. enter each pound water at 180 lb., as against only 3 B.Th.U. additional = 1200 B.Th.U. at 225 lb.—and also by the extra long maximum valve travel, which Mr. Churchward, despite opposition, prevailed in introducing. This reduces the compression period and therefore increases the card area and pulling power of the engine at high speeds. With sliding valves it equals, practically, four drop valves per cylinder actuated by trip gear; it gives a free exhaust; and Lincolnshire inhabitants told me that they were struck by the low distinct G.W.R. exhaust, as compared with the sharp, noisy roar of the "Pacific," which reminds one of a "Sentinel" wagon exhaust as it takes the gradient at New Southgate.

This is a very valuable feature of G.W.R. design, and it is not the fault of the G.W.R. if other companies have feared to follow its example; but it might, I think, give even better results without the long and small crooked pipes which encumber the G.W. locomotive front-ends. With this admirable detail the results are good, in spite of the design of the engine proper.

Both engines may be regarded as "limited cut-off" machines, with a cylinder capacity far exceeding the boiler power. In the G.W.R. there is no mechanical restriction of the cut-off—the drivers do not require that—but the N.E.R. "Pacific"

is limited to 65 per cent. maximum cut-off, and with this over-cylindering, the need of boosters does not occur. From the *Magazine* it appears that the G.W. engine has 9 cubic inches cylinder volume per square foot of heating surfaces, and the N.E.R. 7 cubic inches, the purpose being to obtain the longest expansion possible in single cylinders, and, consequently, the maximum economy, if the cut-off used is not less than 30 to 28 per cent. These ratios may be appreciated by a comparison with the 4.9 cubic inches of cylinder per square foot of heating surfaces of the most recent Midland locomotives—an example of considerable under-cylindering for the boiler steam.

With its special steam distribution, the G.W.R. engine may allow a slightly longer expansion, without loss of economy, than the N.E.R. engine. One of the most popular of long lived mistakes has been to suppose that a five-fold expansion in simple cylinders will be more economical than one of 2.5-fold. Innumerable tests, and long working experience, show that 20 per cent. cut-off is not more economical than 45 per cent., because at the lesser cut-off the negative horse-power is very high, and the proportion of effective turning effort is less, while the proportion of block thrust has increased. A G.W.R. locomotive, "tuned up," consumes 21 lb. of steam net per indicated horse-power hour at an average of 23 per cent. cut-off, while not more than 21 lb. are consumed at 40 per cent. cut-off with a throttled regulator, because the throttling adiabatically superheats the steam and increases its specific volume per pound of water present, the steam being thus more cheaply produced, while the engine does more effective mechanical work by the longer cut-off. This was proved by the tests made by Messrs. Ivatt and Dugald Drummond in opposition to the strong popular fallacy of "short cut-offs for economy." In the U.S.A. this fallacy has led to the use of automatic cut-off control, which, when carefully adjusted for maximum economy, automatically keeps the cut-off above 40 per cent., or 2.5-fold expansion. In compound expansion this cut-off gives a six-fold expansion. The G.W.R. is noted for its minimum cut-offs, and in the tests of the Caldicott Castle in March, 1924, with a train of fourteen cars and dynamometer—about 450 tons—between Swindon and Plymouth, the net steam consumption—deducting injector losses and coal spraying—was 20.9 lb. per indicated horse-power hour, with an all-through average of 694 indicated horse-power, or 9 indicated horse-power per ton of engine. All must admit that the "Castle" type is the most economical and powerful British locomotive. Yet we have much to learn in handling the steam. Thus, at 40 per cent. cut-off average, on a bank 82 miles long, rising 1060ft. net, with four 19in. by 25.5in. cylinders, but with a smaller boiler and pressure than in the N.E.R. "Pacific," the steam consumption is still only 20.6 lb. per indicated horse-power hour with a car load of 487.5 tons, while averaging about 55 miles per hour up to the summit, and indicating an average of 2051 indicated horse-power on the steepest section of 1 in 125—about 20 miles long. Considering that the boiler in this case is smaller than in the N.E.R. "Pacific," and that the engine is worked continuously at 93 per cent. of its maximum power, the only available explanation of this superior efficiency is the method of throttling down the steam and operating with 40 per cent. cut-off, when the cards practically equal those obtained with four-valved cylinders and trip gear—see page 509, June 8th, 1917. The engines here referred to are now extinct practice, the compound type giving yet 53 per cent. higher draw-bar power per ton of coal consumed.

June 8th C. R. K.

SIR,—In view of your usual fairness of editorial opinion, I was certainly surprised to read the article on the locomotive trials in your issue of Friday last, as personally I consider that the G.W.R. deserve every credit for the excellent performance put up by their "Castle" type of engine, and I think they are justified in giving the particulars they have, especially as they stated they would do so in the April issue of their magazine.

I think the majority of engineers outside the G.W.R. naturally thought that the G.W. engines would show up unfavourably in comparison with the much larger "Pacifics" when hauling heavy trains on fast timings, especially on the G.N. section and using Yorkshire coal, but the results of the trials prove otherwise, and that although the G.W. engine has over 25 per cent. less grate area, it was able to do all that the larger engine does and with a slightly lower coal consumption.

I note that the L.N.E.R. in their reply to the Press maintain that the economy of the G.W. engine was due to the higher boiler pressure, but it is a well-known fact that the gain in thermal efficiency due to increase of steam pressure from 180 lb. to 225 lb. is very slight, and in any case should be more than compensated for in the Doncaster engine by the very much greater superheating surface of the latter and consequent higher temperature of the steam.

At the same time, it is undoubtedly a fact that the fine performances put up by the G.W. engines is partly due to the higher boiler pressure used and consequent higher mean effective pressure in the cylinders at high speed.

High mean effective pressure has always been a feature of G.W. engines of recent years, and, besides the higher boiler pressure, other contributory factors are the very careful—even if somewhat elaborate and costly—design of the steam piping, steam and exhaust ports and blast pipe. In addition to these points, I think I am right in saying that the "Castle" class engines have a valve travel of 7in., against only $4^{9}/_{16}$in. in the case of the L.N.E. engines, and this results in a much sharper cut-off at high speed and quicker exhaust opening. Also flat box type pistons are employed by the G.W., with corresponding flat type cylinder heads, giving a minimum of surface on which condensation can take place. Then, again, as regards the boiler, the G.W. is a well-tried type and the result of much experiment, and for its size is probably the most efficient locomotive boiler in existence, both as regards fuel consumption and output.

Another factor is that a 30ft. grate is probably about the maximum that can be fired efficiently by one man, and a long deep fire-box such as the G.W. is generally assumed to be more efficient than a shallow broad box.

It is such points as these that trials of this sort bring to light, and I think that an open-minded discussion of same in your columns will result in much useful information.

As regards the L.N.E.R. statement that their engine ran from Westbury to Savernake in 26 min., with a load of 345 tons, with a minimum speed at the top of the bank of 64½ miles per hour, this is a fine performance and better than anything I have personally timed over this section. At the same time, I would like to refer to an article on page 142 of your issue of February 11th, 1910, where your contributor gives particulars of a run behind the engine Knight of St. Patrick, with a load of 310 tons, when the distance between Westbury and Savernake was covered in 25 min. 3 sec.—*i.e.*, 57 sec. less than the L.N.E.R. claim—with a minimum of 62.1 miles per hour at the summit. The load in this case was certainly 35 tons less than in the case of the L.N.E.R. engine and the summit speed 2½ miles per hour lower, but the engine was one of the first of the four-cylinder class on the G.W., with only 27ft. grate area and 26,000 lb. tractive effort. This also was an every-day run, and not a special trial, so it is evident that the "Castle" class should have no difficulty in beating the L.N.E. engine's time over this section. At the same time, it would be interesting to hear from the G.W. authorities exactly what they have done with a "Castle" engine up the Savernake bank, and to have also a log of the run done on April 27th, when their own engine gained 14½ min. on schedule between Exeter and Paddington.

I may say in conclusion that I have no pecuniary interest in either line, but have been a well-satisfied passenger on both.

E. WYETT.

London, S.W. 18, June 8th.

SIR,—As an old pupil of Mr. Dean at Swindon in the early 'nineties and consequently somewhat pro-Great Western, I may perhaps be allowed to substantiate the article in your edition of the 5th inst. without being suspected of any bias against the Swindon authorities.

Like yourself, I read the report of the locomotive trials, and especially the deductions therefrom, in this month's *G.W.R. Magazine* with some surprise. Passing over their doubtful good taste, I think it safe to say that the deductions were not justified by the facts. The run between London and Plymouth includes about 80 miles of downhill in each direction, and over the greater part of this the "Pacific" engine, owing to its greater weight and higher centre of gravity, found the road unsuitable and had to be run at a speed of some 6 miles an hour less than the "Castle." Added to this the N.E.R. driver slowed down at the service slacks to about 15 miles per hour, while the G.W. driver passed them at nearly full speed. These two items would account for perhaps twelve minutes, which was made up chiefly on superior uphill running, the larger boiler and heating surface of the N.E. engine enabling it to do this at any rate approximately. It must also be remembered that the "Pacific" engine, with tender, weighs 28 tons more than the "Castle," which at a resistance of 16 lb. per ton at 60 miles per hour would be equal to an extra 35-ton coach.

But the most extraordinary statement in the report is that the differences in pressure had nothing to do with the relative coal consumptions, and in support of this the writer says:—"To have worked the 'Pacific' engine at a higher pressure would have meant the consumption of even more coal," &c., quite forgetting that as the pressure increased the cut-off would be gradually brought back from about 35 per cent. to about 15 per cent., which would be approximately what the "Castle" would be worked at on the level, and the tendency all the time would be to decrease the coal consumption. This saving would, however, be at the expense of an extra expenditure on boiler construction and upkeep. As you so truly say in your article, the two propositions are:—

(*a*) High pressure, with consequent saving of coal and higher boiler costs; or

(*b*) Lower pressure, with higher fuel costs, but a saving in boiler construction and maintenance costs.

It is perhaps worth noting that the best performance was when the "Pacific" lost time on Friday to Westbury against a half-gale from the north-west.

No one doubts that Mr. Collet and his able staff have evolved an exceptionally fine engine and probably one that utilises as high a percentage of coal heat value as any simple engine running.

Reading, June 9th. H. R. SUTTON.

PAPERS AT THE IRON AND STEEL INSTITUTE.

SIR,—I was very interested in the article referring to the Iron and Steel Institute which appeared in the last number of the able Metallurgical Monthly Supplement to your journal. The note struck in your article is in harmony with what is in the minds of many members, not only of the Iron and Steel Institute, but of the other national institutions as well. As, however, your article refers only to the Iron and Steel Institute, I venture to confine my comments to this society, especially as it represents one of the most important staple industries of the country. If the progress of development in the iron and steel industry is represented by the programme brought before the annual meeting in May, then one can only conclude that there is something radically wrong. Of the fourteen papers submitted, only one dealt in any degree with the subject of production, the remainder being contributed by those engaged in scientific research. It is appreciated that scientific research is not only desirable, but absolutely essential to the progress of the industry, but when the subjects selected for research usually deal with some super-scientific deductions which the super-scientific people themselves cannot agree upon and which as a rule affect the iron and steel industry not a whit, it does become a question as to what useful purpose they serve. Reviewing the published "Proceedings" of the Institute since the war, one is struck by the paucity of papers to which one can turn for help in the actual work by which the industry exists. If we refer to the "Transactions" of the American Iron and Steel Institute or to those of the American Institute of Mining and Metallurgy, or again to the records of the German Iron and Steel Institute, we find a very different state of things, and unless some efforts are made to rectify the present tendency, I am afraid that the prestige which the Iron and Steel Institute has held for so long as the leading metallurgical society of the world will pass away.

It would take too long to traverse all the reasons for the present position. Most of them are well within the knowledge of any thoughtful member. It does seem, however, that the Council consisting, as it does, of members who are the reputed leaders of the industry, could bring considerable influence to bear in encouraging within the organisations which they control the preparation and presentation of papers. It seems to me that in many works the preparation of papers is discouraged for fear that something which the firm deem of value may be disclosed. Such a point of view can only be held by men who are living twenty years behind the times, since there is very little in the metallurgical world to-day which it is not possible to discover, however secret the owners may deem their information to be. What is wanted essentially are researches into those works processes which are usually deemed commonplace. The point of view which is required on a progressive plant to-day is that nothing should be taken for granted, but that every section of the process should be open to strict investigation in order to determine whether some improvements which would lead to economy cannot be made. The records of such investigations presented for discussion before the members of the Institute would, I venture to suggest, not only stimulate interest in the Institute itself, but also be of value to those who have presented the papers. Surely the time has come when the iron and steel industry should recognise that no one firm can live alone, but that the outlook must be national, both commercially and scientifically, and the natural place for the expression of the latter is through the medium of the Iron and Steel Institute.

June 9th. A MEMBER.

WATT AND WOOLF.

SIR,—In Messrs. W. and T. Avery's museum at Soho Foundry—the old home of Messrs. Boulton and Watt—there is preserved a copy of the *Star* newspaper, dated September 14th, 1811, which contains an extremely interesting account of a trial alleged to have been made of a Boulton and Watt engine and of the results of similar trials made on "Woolf's Patent Steam Engine." I forward you a copy of the article, which, I presume, was really an advertisement in the Woolf interest.

I cannot remember ever having seen a reprint of this document, and suggest it may be of interest to the large number of your readers who, thanks largely to your initiative and help, are deeply interested in the early history of the steam engine.

I have no reliable information to hand as to the state of development of the Woolf engine at this period, but believe this inventor was using steam at a much higher pressure than Boulton and Watt cared to employ at this date. The first of these great men had died in 1809, but Watt, although in retirement, was still living at Heathfield Hall, where he died in 1819.

W. A. BENTON,
Technical Adviser, W. and T. Avery, Ltd.

Woolf's Patent Steam Engine.

London, April 17th, 1811.

This is to certify, That we, the undersigned, were present on the 14th March, 1811, on the premises of John Hodgson, Esq. and Co. at Battersea, to witness an experiment made with a Steam Engine of eight horses' power erected by Messrs. Boulton and Watt, to ascertain what quantity of Wheat could be ground by the said engine with a given quantity of coals. The Engine was in good working condition, the Millstones in good order, and the experiment was made with one pair of Stones, French burs, 4 feet 2 inches diameter.

The Engine was worked with proper care and attention for three hours and fifty minutes, and in that time ground three quarters, seven bushels and a half of Wheat, Winchester measure, with five bushels and one third of a bushel of Coals. The weight of the Wheat was 59 pounds, neat, per bushel. The Coals were from Collingwood Main, 448 pounds.

James Burton, Engineer. Richard Dewdney, Miller.
John Penn, Engineer. George Nicholls, Miller at Messrs. Hodgsons.
Richard Pierce, Miller.

London, 17th April, 1811.

This is to certify, That we, the undersigned, were present on the 17th April, 1811, on the premises of Messrs. Woolf and Edwards, Mill-street, Lambeth, to witness an experiment made with a Steam Engine, constructed by them on Mr. Woolf's Patent Principle, to ascertain what quantity of Wheat could be ground by the said Engine with a given quantity of Coals. The Engine was in good working condition, the mill-stones in good order, and the experiment was made with two pair of stones, French Burs, four feet diameter. The Engine was worked with proper care and attention for two hours and 44 minutes, and in that time ground 33 bushels of wheat, Winchester measure, with one bushel, three pecks, and 14-lbs. (say 161 lb.) of Coals of Collingwood Main. The weight of the Wheat was 59 pounds neat, per bushel. The Engine is estimated at nine horses' power.

Richard Trevithick, Engineer. Richard Dewdney, Miller.
James Burton, Engineer. George Nicholls, Miller at Messrs. Hodgsons.
John Penn, Engineer.
Richard Pierce, Miller. Henry Harvey, Iron Founder.

On the 12th day of July, 1811, an experiment, similar to the above, was performed with Woolf's Engine, at Woolf and Edwards, when upwards of 34 bushels of Wheat were ground into Flour, with two bushels or 168 pounds of Newcastle Coals. The Wheat was of the weight of 59½ lbs. per bushel. Certified by

Peter Keir, Engineer. John Norton, Engineer.
Bryan Donkin, Engineer. Joshua Field, Engineer.
Richard Jackson, Engineer. James Smith, Engineer.
John Penn, Engineer. Chas. Fairborne, Mathematical instrument-maker.
James Burton, Engineer. Richard Dewdney, Miller.
Joseph Machin, Engineer.
John Edwards, Engineer.

London, July 19th, 1811.

This is to certify, That we, the Subscribers hereto, were present on the Premises of Woolf and Edwards, at Mill-street, Lambeth, on Friday the 19th day of July, 1811, to witness an experiment, made with a Steam Engine of Arthur Woolf's Patent Construction, to ascertain how much Wheat could be ground into flour by two pair of French bur stones, of four feet diameter each, attached to the said Engine, with a given quantity of Coals, and that the following was the result. Worked the Engine four hours and 11 minutes, and burnt 3 bushels of Newcastle Coals, weighing 252-lbs. During the above time and with the above quantity of fuel, one pair of the above Stones ground 36 bushels and 44½ lbs., and the other pair 24 Bushels and 25 lbs., making together 61 Bushels and 13½ lbs.; and it is our opinion, that if the second pair of Stones had been in as good order as the first, there would have been ground with the above fuel at least 73½ Bushels. The Wheat weighed 57½ lbs. per bushel.

Joseph Bramah, Engineer. John Dickson, Engineer.
John Penn, Engineer. John Sherwin, Engineer.
John Edwards, Engineer. Thomas Rowntree, Engineer.
Peter Keir, Engineer. Charles Fairborne, Mathematical Instrument Maker.
James Moorman, Engineer.
James Smith, Engineer. Thomas Jones, Mathematical Instrument Maker.
Richard Jackson, Engineer.
John Norton, Engineer. Richard Dewdney, Miller.
Joseph Machin, Engineer. George Nicholls, Miller.
James Burton, Engineer.

From the above Certificates it appears, that with one of Messrs. Boulton and Watt's best Engines, of eight horses' power, not quite six bushels of Wheat, Winchester measure, can be ground into flour with one bushel or 84 pounds of Newcastle coals; and that with the same quantity of coals, Woolf's nine horse Engine can grind from 20 to 24 bushels of the same wheat. In other words Woolf's Patent Steam Engine of nine horses' power can lift from 40 to 45 millions of pounds one foot high, with one bushel of coals.—Engines of greater power can lift considerably more with the same quantity of fuel.

For Licences to construct or use Woolf's Steam Engine, apply to Mr. A. Woolf, Camborn, Cornwall; or to Mr. Alexander Tilloch, Star Office, Temple Bar.

N.B.—Engines on Mr. Watt's Principle may be altered so as to embrace Woolf's improvements, at a moderate expence.

Railway Matters.

IT is announced that another British railway has decided to utilise the Government surplus locomotives. The Great Western Railway has purchased 80 of the remaining 2–8–0 type heavy goods engines which were in the hands of the George Cohen and Armstrong Disposal Corporation for disposal, and they will be passed promptly into service. The London and North-Eastern Railway has already taken 173 of the same type, while the Southern Railway absorbed all of the 50 2–8–0 mixed traffic engines built at Woolwich, and the Great Southern Railway of Ireland is building a second batch of 15 similar engines from sets of parts. The Metropolitan Railway also had six side-tank engines built from these sets.

IT was suggested in the note on "A Large Trade Union Alliance" on our Journal page last week that the prospects of an agreement at the joint conference of labour leaders in London on the 4th instant were not bright. The results were as anticipated; whilst the proposals were not definitely negatived, the resolution to refer them to a committee had the same effect. The objections raised by Mr. J. H. Thomas on behalf of the railwaymen appear to have settled the question. He pointed out that the rail way unions were bound by the conciliation machinery of the Railways Act, 1921, and that that machinery, with which the unions were satisfied, would be imperilled by their adhesion to a strike alliance.

THE report by Major Hall on a collision which occurred on the evening of February 26th at Cogan, on the Great Western Railway, has recently been issued. There was occasion for a light engine to pass from the up line into some sidings on the up side, but as another train was in the way the light engine had to wait for the train to move. The position taken up by the former was between the points in the main line and the safety points in the siding. Standing there it was off both points, and they could be closed without the signalman being aware that the up main line was fouled. That was just what happened, and a passenger train struck the light engine broadside. Seven passengers were hurt, one of them severely. Major Hall blamed the signalman and, moreover, said that it was not a case that called for a fouling bar or its equivalent.

WHEN the work of taking down some of the roof between the Victoria and Exchange stations, Manchester, was in hand recently a girder fell and brought down another on which some men were working and three of them were killed. At the coroner's inquest that officer said it was clear that this was a rush job which had to be done on a Sunday, when there was not much traffic, and it was a job which should have been fully prepared for beforehand. It was evident that the three purlins which were left in and which were admittedly rotten were not sufficient support. One of them gave way, and that was the immediate cause of the accident. H.M. Inspectors of Factories were of the opinion that the safe course to pursue in any dismantling work of this character was that the principals should be lashed with stout poles, and he trusted that this unfortunate occurrence would call the attention of all who were engaged in such work to that fact. He returned a verdict of accidental death in each case.

THE Ministry of Transport's Railway Statistics for the month of February have recently been issued as a Stationery Office publication. The announcement to this effect gives a brief summary of the results of the month's business, but it fails to explain that the receipts for February last were for the usual 28 days, and compared with those for 29 days in February, 1924, which was a leap year. That fact, it seems to us, should be remembered, as it no doubt accounts for the decrease of 0.3 per cent. in the number of passenger journeys, and for that of 2.8 per cent. in the passenger receipts. The latter, it is satisfactory to note, was accompanied by a decrease of 3.5 per cent. in the passenger train mileage. The decrease of 12.6 per cent. in the tonnage of coal and coke was, unfortunately, attended by a drop of 9.9 per cent. in general merchandise, and the total ton-mileage was consequently down by 11.6 per cent. and the freight receipts by 9.3 per cent. The freight train mileage was, however, reduced by 7.8 per cent.

THE retirement is announced of Major-General Sir Harry Freeland, R.E., for five years the agent, *i.e.*, general manager of the Bombay, Baroda and Central India Railway. When traffic superintendent of the North-Western of India he had charge of the railway arrangements for the Delhi Durbar in 1911 and there successfully used the A.B.C. train dispatching system as employed on the Northern Pacific Railway. A description of that system, by Major Freeland, appeared in the *Royal Engineers' Journal* of June, 1912. He was Deputy Director-General of Transportation during the war and rendered particularly useful service on the Italian lines. It spoke well for Major Freeland's abilities that in the chaos in Indian transportation early in 1918 he was sent back to India to become an additional member of the Railway Board in order to deal with the difficulties. For those services he was made a K.C.S.I., and in 1920 went to the Bombay, Baroda and Central India to fill the position from which he now retires.

THE rating of the railways is one of the most complicated questions possible. A railway not only passes through many parishes—possibly with no more than two lines, or even one line, of way—but its rateable value is difficult to assess. This has, however, been recognised by the rating authorities, and the relations between the latter and the companies have been quite happy. The Rating and Valuation Bill, introduced recently by the Minister of Health, has had to make provision for the rating of railways, and the clauses relating thereto have been agreed to between the parties concerned. When the Bill came up for second reading lately some members asserted that the arrangements would relieve the companies and throw an extra burden on the public, and that, therefore, the railways welcomed the Bill. Sir Kingsley Wood was, however, able to explain that no relief in the way of rates would come to the companies, but they would be spared a multiplication of work and calculations and the preparation of innumerable documents. It was on those grounds that the railways welcomed the Bill.

Notes and Memoranda.

THE third memorandum of the Fuel Research Board deals with the manufacture of power alcohol from root crops. It is shown that a ton of potatoes will produce 20 gallons of 95 per cent. alcohol, while artichokes produce from 15 to 25 gallons a ton.

A THREE-STOREY house of brick and wood construction, estimated to weigh 450 tons, was recently moved a distance of three blocks and made to turn three corners, in Schenectady, New York. The house was situated in one of the older sections of the city where streets were exceptionally narrow, so it was first necessary to cut the house in two sections and move one at a time.

A NOVEL type of hydro-electric plant has been set to work by an American firm in Yungan, Fukien, China. It comprises a 36in. turbine working under a head of 10ft. and driving a vertical shaft reaching above the dam. Bevel gearing and a belt are used to drive the 25 kilovolt-ampère generator which is arranged on a lighter moored on the upstream side of the dam. This arrangement was adopted so that the electrical plant would be safe in case of flood. The set lights the native city.

COMMENTING on the explosion of a water-tube boiler, through the failure of one of the inspection caps, the Engineer Surveyor-in-Chief, Board of Trade, remarks:—Fittings of the type of the one which failed in this case are sometimes subjected to very severe stresses, as there is a strong temptation to the operatives in the endeavour to ensure tightness to overstrain them in making certain of a tight joint. A competent man is, as a rule, able to detect an overstrained and defective bolt or clamp when screwing up the nut.

FOR the purpose of electrifying part of the Victorian Government Railway two of the sub-stations are being equipped with Brown-Boveri automatically-operated rectifier plants. Each sub-station will be provided with a 900-kilowatt transforming and rectifing set, which will include two rectifiers, converting the three-phase supply at 17,000/19,000 volts and 25 periods to 1500 volt direct-current. Each set is to be capable of carrying overloads, after eight hours' working at full load, of 50 per cent. for two hours and 270 per cent. for thirty seconds.

AN exhaustive survey of the fuel situation in Central Canada, with special reference to the advisability of developing the coke industry, has recently been completed by the Dominion Fuel Board, and the Board has now issued its findings and conclusions in a report entitled "Coke as a Household Fuel in Central Canda." As a result of its investigation, and as a means of securing independence in the matter of domestic fuels, the Board advocates the erection of a number of by-product coking plants at strategic points in Ontario and Quebec. With the rapid depletion of the oil reserves of the world, the demands of the Dominion for suitable fuels are becoming more and more insistent, and it is believed that future demands in this direction will be economically met by by-product fuel. From a commercial standpoint, there is no question that by-product coking plants can be successfully introduced into the Dominion.

SOME tests carried out by the American Bureau of Standards on the fire-resistance of concrete columns showed that quartz, chert, or granite induce spalling and cracking of the concrete when subjected to fire, while that made with calcareous aggregates, such as limestone or calcareous gravel, shows little visible effect even from very severe fires. As made with trap rock or blast-furnace slag, the fire effects are intermediate between those above indicated. Shape of section or type of column reinforcement were shown to be of minor importance. It was further shown that, with concrete protection of siliceous aggregates or of plaster subject to cracking and spalling, a large improvement can be effected by placing metal ties, such as wire mesh, in the protection. Columns made with siliceous aggregates and thus protected withstood, under working load, fires of four hours' duration, and at their conclusion in the heated condition loads from two to over four times the working load.

ONE objection frequently offered to powdered coal is that it is explosive. Under certain conditions powdered coal is explosive, but with ordinary care it is, the American Bureau of Mines points out, no more dangerous than other things found in power-station equipment. Boilers explode, large turbines occasionally go to pieces, electric currents kill. Gas is used in countless houses and petrol in millions of motor vehicles. Both are explosive, both may imperil life and property; but when an accident occurs the reason for it is found and then provision is made to avoid its recurrence. Powdered bituminous coal will explode in suspension in the air; that is, when it is in the form of a dust cloud. Under this condition the dust must be ignited by a flame or static sparks and the intensity of explosion depends upon the proportion of dust and air. When lying in a bin, coal dust will not explode if a burning stick be thrust into it. Therefore, to prevent an explosion, dust clouds and flames must be kept apart.

A TALL chimney, built of reinforced concrete in 1914, was recently demolished in America by blasting with dynamite. To bring the chimney down 24 holes were, says the *Iron and Coal Trades Review*, drilled on one side of the base, each hole being loaded with half a stick of 1¼in. by 8in. of 40 per cent. dynamite, and fired with instantaneous electric blasting caps. The shot only broke out a segment of concrete, leaving the reinforcing bars intact, and the chimney standing as before the blast. Holes were next drilled in the remaining half of the chimney base, arranged like those of the first shot. Each individual load consisted again of a half cartridge of a 1¼in. by 8in. of 40 per cent. dynamite, all being connected together and fired with instantaneous electric blasting caps, as before. The second blast, besides destroying the whole of its base, actually moved the stack 3ft. to one side of the original position, and left it standing upright. The third shot consisted of two lifting holes placed under the base, and these, when loaded and fired, threw over the chimney. The entire middle section remained undamaged by the fall, and was salvaged for use as a culvert, which speaks well for the construction of the chimney.

Miscellanea.

THE Birmingham electric supply scheme made a profit of £89,370 last year.

KNUTSFORD (Cheshire) Council has decided to spend £61,500 on an extensive sewerage scheme.

THE electric power plant at Worksop is to be extended to cope with the increasing demand for current.

TRACES of oil are said to have been found by the Burma Oil Company in the hilly district near Patiya, an outlying station of Chittagong.

IT is now reported that the original Wright aeroplane will not come to this country, but will be presented to the Smithsonian Institute at Washington.

IT has been decided to wind up the Midland Re-afforesting Association, largely on account of the wanton destruction of the plantations which have been made.

IT is proposed to construct a new bridge over the Thames at Hampton Court and to demolish the old structure. The works will cost nearly half a million.

THE old bridge at Bideford, which has been in existence since the fourteenth century, has been reopened after reconstruction and repair. The bridge has been widened 7ft.

THE abolition of level crossings in Hull, which has been approved by the London and North-Eastern Railway, is to cost £1,157,000, of which amount the Ministry of Transport will contribute two-thirds.

THE whole of the six dock gates at Grangemouth were recently removed to graving dock, given a general overhaul and replaced. Each gate weighs 160 tons and was moved by floating it off its seatings.

THE lead mines of the Halkyn District of Flintshire are to be reopened, the Flintshire Mines Draining Company having decided to amalgamate with the various mining companies. The Flintshire lead industry is the oldest in Wales, and employs large numbers of miners and operatives.

THE Acting British Consul at Oslo has informed the Department of Overseas Trade that, according to the local Press, the date of the exhibition of radio goods to be held in Oslo has now been altered. The Exhibition will be held from September 24th to October 4th next, and not as originally intended from September 1st to 15th.

WHEN the deputation from the Midlands visited the Minister of Transport recently to put before him the claims of the Birmingham-to-the-sea canal scheme for 100-ton barges, the Minister was unable to make any definite statement as to the nature or amount of assistance which Parliament might afford the proposals.

WE are asked by the Anna Liffey Power Development Company, Ltd., to say that the report by Dr. H. H. Jeffcott on the Shannon power scheme, to which we referred in a leading article in our issue of May 22nd, was printed privately, but may be obtained from Messrs. Hodges and Figgis, Nassau-street, Dublin. Dr. Jeffcott—inadvertently referred to as Mr. Jeffcott in our article—who is now the secretary of the Institution of Civil Engineers, was secretary to the Water Power Resources of Ireland Committee in 1918–1920.

WHAT is said to be the largest hydro-electric plant in South America has been opened on the Ilha dos Pombos, in the Parahyba River, close to the town of Antonio Carlos. The plant, which is intended to augment by 50,000 kilowatts the existing installation furnishing power to Rio de Janeiro, contains two large electric generators driven by hydraulic turbines, so arranged that additional units may be added. The transmission line, 155 kiloms. in length, consists of two three-phase circuits, carried on steel towers on which the current may be transmitted at 132,000 volts. The voltage at present in use is 88,000.

A COMPANY has been formed, according to the *Iron and Coal Trades Review*, for the purpose of erecting a plant near Burnie (Tasmania) to smelt iron and steel electrically. The iron ore deposits of the Hampshire district, which are to furnish the supply, are said to be very rich. The plant will be served by the Emu Bay Railway Company, which runs close to the deposits at Hampshire, 20 miles from the port. Negotiations have been entered into with the Tasmanian hydro-electric department to secure power and such coal as will be necessary. It is anticipated that about 40,000 horse-power of electric energy will be available for use within twelve months.

THE total imports of motor cars into India during the year ended March 31st last rose from 7984, valued at 205 lakhs, to 9380, valued at 220 lakhs. This increase has been contributed to by most of the supplying countries, but it is satisfactory to observe that, owing to recent reductions in the prices of the leading British makes, the ratio of increase is greatest in the case of the United Kingdom. The number of British cars imported rose from 1005, valued at 45 lakhs, to 1682, valued at 61 lakhs. The Canadian imports rose from 3290, valued at 64 lakhs, to 3956, valued at 65 lakhs. American shipments advanced from 2865, valued at 69 lakhs, to 3106, valued at 73 lakhs. Arrivals from the Continent remained stationary. Belgium contributed 136 cars, France 160, and Italy 235.

THE New York Edison Company announces that it has completed plans for the erection at New York of the largest electric generating station in the world. The plant will cost 50,000,000 dollars, will have a capacity of 700,000 kilowatts, or approximately 1,000,000 horse-power, and will exceed by 100,000 kilowatts the capacity of the projected power development at Muscle Shoals. It is expected that the building itself, which will cost approximately 12,000,000 dollars, will be completed by the end of the year, and that the initial installation of generating equipment will be completed in the spring of 1926. The station will contain nine turbo-generators, each having a capacity of 60,000 kilowatts—80,000 horse-power—and additional equipment which will give the station a total capacity of 700,000 kilowatts. The contract for the first two of these machines has been given to the General Electric Company of Schenectady, N.Y. Each generator will weigh 1,182,500 lb.—nearly 528 tons.

THE NECHELLS ELECTRIC POWER STATION OF THE BIRMINGHAM CORPORATION

(*For description see page 660*)

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DEATHS.

On the 9th June, at a nursing home in London, SAMUEL MECHAN, of 50, Morpeth Mansions, S.W. 1, and Mechans, Ltd., Glasgow.

On the 9th June, at 31, Idmiston-road, West Norwood, WILLIAM JOSEPH DIBDIN, F.I.C., F.C.S., aged 74.

On the 3rd June, EDWARD FREDERICK SPURRELL, Engineer and Surveyor, Metropolitan Borough of Holborn, aged 56.

THE ENGINEER.

JUNE 12, 1925.

Papers and Discussions.

IN the May number of our new monthly Supplement, "The Metallurgist," we touched editorially upon the recent meetings of the Iron and Steel Institute, and compared the listlessness and indifference which seemed to characterise them with the heated discussions of other days. We suggested that the unwelcome change might be due to the disappearance of such giants as Arnold, Stead, and MacWilliam, and expressed the view that since there is "no lack of ability and energy among the metallurgists of the generation following that of the men we have named," it only required a little more vitality in the Council—which could be secured by an infusion of young blood—to restore the Institution to its old vigour. We find, however, that many of the members take quite a different view of the position. They ascribe, as a steelworks contributor to our correspondence columns this week does, the listlessness to the fact that the proportion of papers of the scientific and abstruse kind has become too great, and that there is a marked lack of those subjects which appeal to the man engaged in the direction and management of iron and steel works. As a matter of fact, there was but a single paper at the last meeting—that by Mr. T. W. Hand on "Progress in British Rolling Mill Practice"—which dealt with direct practical problems. The Iron and Steel Institute is not the only society in this country, and in other countries as well, which has been charged with neglect to provide for those members whose interests are rather in the works than in the laboratory. It may therefore be worth while devoting a few moments to the consideration of the problem.

Since the opinion is widely expressed, we may accept it as a fact that an excessive proportion of the papers presented at the Iron and Steel Institute and at other institutions do not appeal to as large a number of the members as they should do. We are unable to find any indication that this attitude is the result of an indifference to scientific research. The old rule-of-thumb man is now very rarely heard in our midst, and, in metallurgical circles particularly, the advantages of the scientific method are readily acknowledged. It is therefore not out of any lack of respect for the work of researchers that the preponderance of their contributions to the meetings is condemned. We will not go so far as to say that everyone thinks that every research paper is worth while. Even the scientists themselves admit that there are grades of value, and that some of the papers contributed to the meetings of technical societies deal with ordinary routine work which is hardly worth reporting at all. But, on the whole, the scientific value of the bulk of the papers is fully recognised and appreciated. Hence, when we find many members rebelling against such papers we must not jump to the hasty conclusion that they are reactionaries. Their objection is not to the papers as such, but that they have been permitted to encroach so much upon the very limited time of the meetings that practical matters—which are of equal importance in a practical world—are neglected. To put it quite shortly, what they ask for, as we understand them, is that there should be as much attention given to practical as to theoretical and laboratory subjects. We may say at once our sympathies are wholly with them. We recognise the great benefits which scientific research has bestowed upon the industries of the world, but before those researches can be given a commercially valuable turn, which is the reasonable ultimate object of all such researches as we have in mind, practical means of carrying them out must be devised. The researcher may be content to say, "There are the results of my investigations; do what you like with them; my interest in them has ceased"; but the man who has got to make his own living by the employment of those investigations, and has, moreover, upon his shoulders the responsibility of keeping a large number of workpeople and a very costly plant in useful occupation, has very different aspects to consider. Let us draw an example from another field. The value of the work that is being done by the Marine Oil Engine Trials Committee is generally recognised. By a series of carefully conducted tests that Committee is laying before the world the efficiencies of certain types of marine oil engines. If the trials began and ended at that, they would scarcely be worth the money that is being expended upon them. It is to the practical results shown by increase of efficiency, reduction of weight, and so on, to which we must look for a return upon the great cost in time and money that is being incurred. We do not doubt for a single moment that every maker who has seen his own engine put through these tests or has studied the results of the tests upon engines of other makes, has learnt something of real practical value from them, something that he can apply for the improvement of his engine, and hence for the general credit of engineers. Such views as these are held, of course, by all engineers; they desire to see a due balance between science and practice. Why is it, then, that the number of scientific papers exceeds the number of practical papers? The answer is that the scientist will write papers and the practical man will not. That, no doubt, is the root of the trouble at the Iron and Steel Institute and elsewhere. The fact is not so much that the Councils voluntarily give precedence to scientific contributions as that there is a real dearth of those practical papers which used to be commonly met with at the meetings of technical societies. It is one that gives cause for some anxiety and demands close investigation. Practical questions are before the iron and steel master and the engineer every day, and all day long. How is it that he finds no time or no inclination to write about them? Put down half a dozen engineers round a table, and in thirty minutes they will be at hammer and tongs over some practical issue. Why is it that those issues so rarely reach the meeting hall? We have heard many reasons adduced, some creditable to engineers or to their natural modesty, some discreditable as indicating a narrowness of vision; some creditable to the rules, written or unwritten, of the Institution concerned, some discreditable to them as exhibiting a lack of progressiveness, a failure to conform with the changing requirements of the day. Different men are influenced by different factors, and when there are so many varied reasons for not writing papers, it is easy to pick out one at least which is an adequate excuse. As an example, we quote a passage from a private letter received since this article was written:—"You will appreciate that life in production works has changed a very great deal during this last fifteen years. The problems which have to be faced have become more intense, and therefore the men who ought to be contributing have often not time enough to do it in the way they would think worthy. Another reason is that the man on

the job gets so used to it, that the problems he is dealing with appear commonplace to him, and therefore he does not feel that they are worth talking about, much less writing about. Everything gets so familiar that he forgets the relating of it to others, who know very little or nothing of what he is doing, would be mighty interesting as well as informative. Further, the tendency in all the institutions has been for the contributions to become increasingly learned, and the man whose work and general training would perhaps only fit him to give a plain unvarnished story of what he is doing, feels somewhat shy of sending contributions which he thinks may be judged by the standard which he himself has set up by the perusal of papers which, frankly, he cannot understand; he forgets that probably about 95 per cent. of the rest of the members are in his category." And so the institutions see the number of scientific contributions which are offered to them multiplying, whilst the practical papers become fewer in number.

We shall be quite fairly asked if we have any suggestions to make which would lead to the desired improvement. Frankly, we have nothing definite to offer, but we ask the practical men who complain of the lack of practical papers to remember that they have themselves to blame, and we appeal to them to search their minds for subjects, and then to devote some small pains to the preparation of them in a form suitable for discussion. We are confident that the Iron and Steel Institute would welcome more papers like that by Mr. Hand, and that the programme is not voluntarily unbalanced in favour of scientific and abstruse papers, but suffers from that defect because papers of another kind are not forthcoming. The great thing to remember is that the amending lies with the practical men themselves. Let them but resolve to have the kind of discussions they want, and they will certainly have them.

Wrought Iron or Steel.

WITH the advent of cheap mild steel of excellent quality, produced first by the acid Bessemer process, then by the acid open-hearth, and now undeniably obtainable from the basic open-hearth process, it might have been, and in fact was, fully anticipated that the producton of wrought iron by the ancient puddling process would gradually die out. To a considerable extent this anticipation has been justified by events, since the production of wrought iron has fallen off and the material has been very largely replaced by steel. Yet it has steadily held its own to a certain extent, and at one period there was even an increase in its production. At the present time there are still a number of special purposes for which it is preferred or even specified. Progress in the production of steel of high quality, and of a widely varying range of properties, has, however, been so great in recent years that it seems well worth while inquiring whether at the present time the preference for wrought iron is really justified, even for special purposes.

It is, of course, always sad to see an ancient industry die out, particularly as the process is liable to be accompanied by circumstances painful to some of those concerned. At the same time, the pressure of external competition is such that engineers and metallurgists cannot afford the luxury of perpetuating any inefficient process or any inferior product for reasons of sentiment. If it can be shown that a suitable variety of steel can with advantage, either in cost or in quality of product, replace wrought iron, even for the special purposes to which it is now mainly devoted, there can be no doubt that in the interests of engineers in particular, and of national progress in general, such replacement must be made. If, on the other hand, in the light of present-day knowledge and experience it is established that wrought iron still possesses advantages, it becomes a pressing question for the steel metallurgist to provide a product whose properties shall be at least as good as those of the older material, but obtainable by more efficient means and at a lower cost. There are in the main three important properties for which wrought iron appears to be valued. They are: resistance to shock, resistance to corrosion, and ease of welding. That it was, when at its best, superior to steel in these respects, was no doubt true of the steels available fifteen or twenty years ago. It may still be so to-day, but that it is cannot wisely be taken for granted, and there is some room for doubt that the question has been carefully reconsidered in recent years. To take the question of welding alone, which is so largely responsible for the persistent use of wrought iron for chains, there have been great changes and developments. Mild steels and "ingot irons," which can be quite readily welded under suitable treatment, are available to-day. Witness, for example, the fact of their employment for the manufacture of butt-welded tubes. It may be true that the welding of these steels cannot be so easily effected by the somewhat primitive means at the disposal of the makers of small chain, but these methods in themselves appear to be scarcely up to the level of modern metal-working practice, and are likely to succumb to the first well-organised attack. There are, furthermore, the possibilities of the newer methods of autogenous or fusion welding, which are at least as readily applied to steel as to wrought iron. A hammered weld properly made is no doubt superior to a fusion weld if the latter is left untreated. In a great many cases, however, such as chain links, the article could be readily heat-treated after welding, and in that case it seems at least likely that the fusion welded steel would prove superior to the hammer-welded iron. In regard to corrosion also, it is now possible to produce steels or ingot irons of very high purity—if such purity is really of fundamental importance from this point of view. Here also there would seem to be need of careful inquiry into the validity of the traditional ideas on the superiority of wrought iron. Similar remarks apply to the question of shock resistance. We have learnt to realise that while the apparently fibrous structure of wrought iron gives it the advantage of a more or less laminated substance under a shock test, that advantage is adventitious rather than inherent, and that, quite as frequently as not, the discontinuity of structure of the iron is a source of a very real weakness from which steel is free. Even in the very mildest steel we have, moreover, the great advantage of a response to heat treatment which is very slight or entirely absent in wrought iron. Untreated steel may have been seriously inferior to the best wrought iron in its power of resisting shock. Is it true to-day that steel of suitable composition and purity, properly heat treated, is still inferior in this respect to such grades of wrought iron as are at present commercially available?

All these are questions of serious importance, requiring, it would seem, renewed consideration under present-day conditions, and we commend them to the attention both of metallurgists and of engineers who still feel bound to rely upon wrought iron.

Obituary.

JAMES HOLDEN.

THE announcement of the death of Mr. James Holden, at Bath, on May 29th, at a great age, must have brought back to the memory of many of our readers the valuable work he did in the twenty-two and a-half years (July, 1885–December, 1907) during which he was locomotive superintendent of the Great Eastern Railway. He was born at Whitstable, Kent, on July 26th, 1837, and in due course became an apprentice in the railway works at Gateshead under his uncle, Mr. Edward Fletcher. Subsequently for a brief period he was manager of some private engineering works in Sunderland, and in 1865 he entered the railway service in the carriage and wagon department of the Great Western Railway, becoming in succession superintendent of the works at Shrewsbury and Chester. Later he was appointed manager of the extensive carriage and wagon works at Swindon and chief assistant to Mr. Wm. Dean, the locomotive superintendent. Whilst on the Great Western Railway he was intimately concerned in the transformation from broad to narrow gauge.

On the retirement of Mr. T. W. Worsdell from the position of locomotive carriage and wagon superintendent of the Great Eastern Railway in 1885 Mr. Holden was appointed his successor. There, despite the good work that Mr. Worsdell had done during his three years' tenure of office, Mr. Holden found ample scope for his great technical and organising abilities. "Tell me this" were his first words as he came to his office in the morning, and then would follow a string of searching questions as to the organisation, the *personnel*, the locomotives and rolling stock, in fact anything with regard to his department that could occur to an active, inquiring mind. He had the registers of the locomotives, carriages and wagons carefully overhauled until he was satisfied that the information they contained was absolutely dependable. He watched expenditure with an eagle eye and a broad outlook; the resultant economies he effected were very real and much appreciated by the directors of this struggling railway. He found in existence many totally distinct types of locomotives, the results of the various amalgamations constituting the Great Eastern Railway. In a comparatively brief period he brought about a considerable reduction in the number of types and, as far as could be done, effected interchangeability of parts among the survivors.

Mr. Holden was quick to make a virtue of a necessity. Tar from the company's oil gas works was emptied into sumps and found its way into an adjoining river, with the result that the Conservators complained. He decided to burn it, and from the experiments grew his well-known liquid fuel injector, with which at one time—before the price of liquid fuel became prohibitive as compared with that of coal—some eighty Great Eastern engines were equipped. His ingenuity was displayed in two other notable instances. The railway was threatened with a rival enterprise in its suburban area to be worked by electricity, one of the arguments used being that the electric trains could accelerate quicker than steam engines and thus increase the capacity of the line. Mr. Holden opposed this view, and to demonstrate his idea he designed a tank engine with ten coupled wheels—known as the Decapod. He succeeded in obtaining a speed of 30 miles an hour thirty seconds after starting, with a load of 300 tons, and the electrical scheme did not materialise. The Decapod, however, proved to be in advance of the permanent way and bridges and was ultimately converted into an eight wheels coupled goods engine. The second instance was when he had some suburban carriages widened, by what may be termed a surgical operation, in order to increase the seating capacity from five to six a side. This important change he followed by designing new vehicles with the same object, and the suburban stock on the Great Eastern Section of the L.N.E. Railway to-day is of this type.

As a locomotive designer Mr. Holden was responsible for types still running on the Great Eastern Section, notably the 0–6–0 tank engines for goods and suburban passenger work, the 2–4–0 mixed traffic (goods or passenger) engines, the 4–4–0 expresses ("Claud Hamilton" type), and the 0–6–0 goods engines.

An engineering feat during Mr. Holden's *régime* was the assembling at Stratford works, in the year 1891, of a locomotive in the world's record time of ten working hours. That the engine was "well and truly" built was evidenced by the fact that she was immediately put under steam and worked a heavy goods train over a long distance.

Mr. Holden was keen on the practical education of young engineers. He would have them serve the first two or three years in the shops, but he did not undervalue the theoretical side, and indeed was so anxious to give the workmen's sons a chance to reach the top of the tree that he obtained the consent of his board of directors to a scheme by which evening students at the company's Mechanics' Institute at Stratford, who had reached a certain standard of progress, should be allowed leave of absence during the winter months—their wages being continued—to enable them to pursue the higher branches of engineering study at college. This scheme had a far-reaching effect, and many young men who took advantage of it have held high positions in the engineering world. He also considerably improved and extended the usefulness of the Mechanics' Institute to which we have referred.

During the time Mr. Holden was at Stratford the extensive wagon shops at Temple Mills were constructed and the chemical laboratory, Stratford works, was established.

Mr. Holden was a member of the Society of Friends, and for many years conducted a First Day Adult School in a poor neighbourhood in Stratford. This school was run on thoroughly democratic lines, for he had a strong objection to unnecessary rules and regulations. Indeed, one of the proudest achievements of his official career was the building of a dormitory at Stratford for the Great Eastern enginemen, which was a model of comfort and convenience and was subject to one printed rule only, viz., that occupants must wear the slippers provided in order not to disturb those who were asleep.

Mr. Holden was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers; he was also a Justice of the Peace for Essex, and was for three years a member of the West Ham Education Committee.

The Institution of Gas Engineers.

Excerpts from the Presidential Address by Mr. J. Ferguson Bell, M. Inst. C.E., M.I. Mech. E., delivered on June 9th.

THE striking progress of the gas industry in the United Kingdom since 1913 is shown by the returns of statutory and non-statutory undertakings.

In the last five years the output has increased from 242 thousand million to 282 thousand million cubic feet, an increase of no less than 40 thousand million cubic feet, or more than the total gas made by the Gas Light and Coke Company, which is by far the largest gas undertaking in the world. Incidentally, it is interesting to record the fact that the Gas Light and Coke Company alone supplies more heat units than the combined output of all the electricity undertakings in this country. The number of consumers

has increased from about 8 millions to over 8½ millions. The capital employed in the last three years has increased from £156,869,911 in 1920 to £173,470,766 in 1923. This is a growth of £6,600,855, or an average increase of just over £2,200,000 per annum.

This remarkable progress conclusively indicates that town gas in Great Britain is being used in an increasing quantity by an increasing number of consumers.

CHEAP AND AMPLE SUPPLIES OF HEAT ENERGY.

Contrary to the opinion of those unacquainted with the facts, the greatest growth of the gas industry has occurred during the past twenty years. Instead of declining in importance, it is now on the eve of its greatest expansion—given the same consideration as its competitors. The benefits that can be derived from one of the most important key industries in the country are being realised, whereby a substantial increase is obtained in the availability of the potential heat units of the coal used, and at the same time recovery of valuable by-products so necessary to the country in time of peace. Their applicability and vital necessity was demonstrated in a remarkable manner during the war.

The provision of cheap and ample supplies of heat energy in the form of gaseous fuel can be best and most economically provided by the gas industry. In this connection, it is also a remarkable sign of the times that the British Commercial Gas Association has now on record a list of over 4000 trades in which gas is used, with an average of seven processes to each trade. This indicates the immense field there is for future development.

The gas industry has become one of the greatest co-operative efforts in the world. Through the National Gas Council, representing 841 company and municipal undertakings, being 88 per cent. of the total make of gas in the United Kingdom, the industry has combined its forces for the benefit of consumers, employees and producers, very ably guided by Mr. Milne Watson, D.L., the governor of the Gas Light and Coke Company, assisted by an efficient staff.

COAL CONSERVATION.

The importance of a more efficient utilisation of our coal supplies, which are the foundation of this country's industrial position, demands that more attention should be given to this subject. Our national fuel resources are by no means inexhaustible. They are diminishing; yet our wealth of coal is being recklessly squandered in many directions. The burning of raw coal in furnaces and open grates is extremely wasteful, resulting in unnecessary reduction in our national coal resources, and also additional loss to the country by non-recovery of valuable by-products, so essential for many industries.

The more extended use of gaseous fuel for trade and domestic purposes means a substantial increase in thermal efficiency, abating the smoke nuisance, and promoting better health, comfort and convenience, less labour, and improved amenities of our towns. It is estimated that the extra cost for fuel and washing materials attributable to the smoky atmosphere in many industrial areas is equal to 7½d. per week per household, which for a town of a quarter of a million inhabitants means a loss of over £100,000 per annum, and this without taking into account the contributory cause of general ill-health and squalid appearance of those smoke-laden districts.

Nowhere is coal treated with the same overall efficiency as in the principal gasworks of this country, the thermal efficiency being well over 70 per cent.

The total coal mined in the United Kingdom during 1923 was about 250 million tons. Some 186 million tons, or 75 per cent., was for home requirements, of which 38 million tons were used for domestic purposes. The bulk of this is burnt in open fire-grates, giving a useful heat efficiency of only 15 to 25 per cent., and, worse still, serious pollution of the atmosphere by the production of coal smoke and noxious vapours, destructive alike to property and health.

For industrial purposes—other than those of railways, gas and electricity works, coke ovens, manufactured fuel, steamships and exports—72 million tons were used, making, with the 38 millions for domestic purposes, a total of 110 million tons, or 44 per cent. of the total production. Of this, by our present lavish methods, it is estimated we waste some 40 million tons a year, which at, say, 15s. per ton, means a loss of no less than 30 million pounds per annum to the country.

GAS AND ELECTRICAL EFFICIENCIES.

I do not desire to belittle the importance and progress of electricity, or to depreciate the valuable service performed by the electric supply industry, but rather congratulate the electrical industry upon its progress. The handsome dividends it is able to pay its shareholders indicate prosperity, and no necessity for State aid. With electricity at the low price of 1d. per unit, and gas at 8d. per therm, heating operations, irrespective of the type of apparatus, cost from three to four times as much as corresponding operations performed by the aid of suitable gas appliances. It is generally acknowledged that a modern gas engine is one of the most efficient prime movers available to-day; yet there has been a falling off in their use of recent years, as a result of keen competition by electric motors, current being sold at extremely low rates for power purposes. A formidable competitor is also the crude oil engine. There has been a marked decrease in the use of isolated steam power, except for large users or in special cases where steam is required for other purposes. The smaller steam engine, as regards convenience, availability, and costs, compares very unfavourably with gas, oil or electricity.

Electricity is an efficient and convenient means of transmitting power. In some instances electric motors are no doubt more convenient and economical than any other prime mover, but where the load is reasonably continuous, a gas or oil engine may effect a substantial reduction in running costs.

For crude oil engines, with a low price of £6 per ton for crude oil delivered by road tank cars, the fuel costs alone, are less than for town gas, unless supplied at a specially low rate; but this is only one item. The initial cost of an oil engine is greater than of a gas engine. There is the storage of oil and uncertainty as to its price, increased wear and tear, also higher costs for maintenance and attendance, all of which require to be taken into account when estimating overall running costs.

Town gas possesses several advantages over producer gas or oil for power purposes. It is always available, there is no cost of storage or getting in supplies, it is more reliable, needs less attention, and smaller initial outlay is required.

For power purposes it constitutes a desirable proposition, both for suppliers and users. The load factor is a good one, and it will pay gas undertakings to charge lower prices to encourage the extended use of gas for power, to compete with oil and electricity. Severe competition will compel manufacturers to look more closely into production costs, and there are many industries in which a modern type of gas engine will effect an appreciable saving over electric motors.

PROPOSED GOVERNMENT ASSISTANCE TO THE ELECTRIC SUPPLY INDUSTRY.

I do not as a rule refer to a competitive industry; but the proposals put forward that Government assistance should be given to bring about the reorganisation and expansion of the electricity supply industry by an issue of Electricity Bonds to an ultimate total value of £50,000,000, guaranteed by the Government, is so manifestly unfair, not only to the gas industry, but to many other industries, that I desire to enter an emphatic protest against any such one-sided scheme to which there are many objections, both on principle and as regards its application.

There is ample room for both gas and electricity in their own spheres; and before any legislation is introduced, the country ought to be made aware of the whole facts, and an answer given to the very important question, To what extent can power and heat and light be cheapened by the conversion as now practised of the potential energy of coal into electric current, or by the more logical way of distillation for separation into gaseous, solid and liquid products?

It is an admitted fact that the highest thermal efficiency in the utilisation of coal is achieved by the gas industry. The efficiencies of gas and electricity in production, distribution and utilisation are as follows:

	Gas: Average present practice.	Electricity: Average present practice.
Number of heat units delivered to consumer per 100 heat units in coal used—thermal efficiency of manufacture and distribution	47.5	9.5
Number of heat units coverted into useful work by consumer per 100 heat units in coal used—		
For heating rooms	29	9.5
For heating and boiling water	35	4.8
For cooking by oven	6.2	2.1
For power	11.2	8.65

From these figures it is evident that the maintenance and development of the gas industry are essential in the interest of fuel conservation, apart from other questions.

Artificial stimulus to any industry by means of State aid is without precedent, and is essentially contrary to the financial or fiscal policy of this country. State aid to any particular industry constitutes a form of domestic internal protection at the expense of other industries. Coal is our great national asset; and I have already shown that the highest thermal efficiency in the utilisation of coal is obtained by high-temperature carbonisation.

Cheap electricity is not a panacea for all industrial ills. I find that in most industries the percentage for power costs, as compared with total production costs for materials, labour, rates and overhead charges, varies from 1 to under 5 per cent. only—*e.g.*, engineering, 2.95; motor cars, 2.40; printing, 1.90; and paint, 1.95 per cent. For malleable iron castings it is 3 per cent. only of the total cost per ton. Hence, it will be seen that the plausible cry that industry will revive if only manufacturers can obtain motive power at abnormally low rates is misleading, and will only delude those who put their trust in doctrinaire promises.

It should not be overlooked that the gas industry itself employs five men for every one engaged in the electricity supply industry on the same amount of work done.

Government money spent on the development of electricity may be wasted on uneconomic and unremunerative schemes. The electrical industry itself is sufficiently prosperous to pay for any schemes which would result in a fair remuneration on the capital expended. The pre-war and post-war dividends paid by the metropolitan and provincial electric supply companies amply prove this.

Further, it is quite probable that within the next few years a gas turbine will be perfected which may render obsolete the most efficient methods for the generation of electricity in use to-day, and may well make long-distance distribution of electrical current an unnecessary and wasteful practice.

I submit:—

(1) That no case has been made out for any subsidy being granted to the electricity supply industry.

(2) That if the Government is determined to adopt a policy of national subsidies, then all rival and competitive trades and industries should receive like subsidies on the same terms and conditions.

(3) That such subsidies should take the form of loans repayable with interest over a period of years by the industry or undertaking assisted, in a similar manner to loans (sanctioned by the Government) to municipal trading departments.

Literature.

SHORT NOTICES.

Johnson's Materials of Construction. Re-written by M. O. Withey and James Aston. Edited by F. E. Turneaure. Sixth edition. London: Chapman and Hall. 1925. Price 30s. net.—In the present edition of this book of reference two new chapters have been added, one on "Paints and Varnishes," written by O. A. Hougen, and the other on the "Constitution of Some of the More Important Non-ferrous Alloys," written by R. A. Ragatz. In addition, the chapter on the "Fatigue of Metals" has been completely revised. Revision has also been made of certain data on the mechanical properties of timber, of requirements for brick sewer pipe, gypsum wall plasters, and hydrated lime. Some new types of testing machines and apparatus have been substituted for older forms. Other minor changes have been made in methods of testing, and certain errors which it was found had crept into the previous edition have been corrected.

Illuminating Engineering. Edited by F. E. Cady and H. B. Dates. London: Chapman and Hall. 1925. 25s. net.—This volume is composed of lectures given during a period of six years at the Case School of Applied Science in America, with the co-operation of the General Electric Company. It covers the subject most comprehensively—even to the extent of describing the mechanism of the eye. The nature of light, its measurement and effects are dealt with, and the various commercial sources described in detail. The latter part of the volume is concerned with the installation of lighting apparatus, including windows, and gives recommendations for the intensity of illumination for various purposes.

Practical Handbook on Electro-plating. Published by W. Canning and Co., Birmingham. 1925. 4s. 6d.—Only naturally, this book is rather in the nature of an advertisement of the publisher's products, but it contains a vast amount of useful information on the subjects of plating, galvanising, polishing, lacquering, &c. Detail instructions are given for the compounding of the necessary solutions and for their use, while hints are given for overcoming the "snags" which may be expected. Some idea of the modernness of the information contained in the book may be got from the fact that cadmium and chromium plating are described. The book contains some 270 pages.

Examples in Machine Design. By G. W. Bird. London: Sir Isaac Pitman and Sons. 1925. 6s.—In conjunction with a standard work, such as Unwin's "Machine Design," this book should prove useful to a student studying for his B.Sc., as it deals with typical examples of standard engineering practice right through from first principles. The examples given range from a Lancashire boiler to a steam engine cylinder, and a centrifugal pump, while small items, such as a crane hook and a bearing are also dealt with.

BOOKS RECEIVED.

The Advertisers' A B C, 1925. London: T. B. Browne, Ltd., 163, Queen Victoria-street, E.C. 4. Price 21s. net.

The Engineering Index, 1924. New York: The American Society of Engineers, 29, West 39th-street. Price 7 dollars net.

The Railway Year Book for 1925. London: The Railway Publishing Company, Ltd., 33, Tothill-street, S.W. 1. Price 5s. net.

Das Bayernwerk und Seine Kraftquellen. By A. Menge. Berlin: Julius Springer, Linkstrasse 23–24, W. 9. Price 7.50 gold marks.

Technology of Cotton Machinery. Part 1, *Calculations on Pickers.* By A. A. Mercier. Washington: Government Printing Office. Price 10 cents.

Refrigeration in the Chemical Industry. By G. W. Daniels. London: A. J. Rayment, 15, Dartmouth-street, S.W. 1. Price 10s. net.

The Microstructure of a Coal Seam. Fuel Research Board Technical Paper No. 11. By J. Lomax. London: H.M. Stationery Office, Adastral House, Kingsway, W.C. 2. Price 4s. 6d. net.

Uber Wirtschaftlichen Brennstoffverbrauch im Eisenbahnbetriebe. Translated from the Swedish of W. Hansman by H. Bager. Berlin: Wilhelm Ernst und Sohn, Wilhelmstrasse 90, W. 66. Price 3.90 gold marks.

20-Ton Goliath Crane.

WE illustrate herewith a 20-ton electrically-driven Goliath crane, recently designed and built by S. H. Heywood and Co., Ltd., engineers, of Reddish, near Stockport, for the Great Western Railway Company, for use in that company's yard at Small Heath. The crane travels along two rails fixed at 40ft. centres, the total length of the track being 360ft. The main bridge, consisting of two main girders and two auxiliary girders—Fig. 1—is carried on legs of such height as to enable the crane hook to hoist up to a height of 22ft. above the level of the tops of the rails on which the crane travels. The travelling motor—Fig. 4—which is carried on a stout channel framework built between one of the main girders and the adjacent auxiliary girder, has a full load capacity of 23 brake horsepower, and the power is transmitted through a pair of high carbon steel spur wheels to a horizontal shaft 2⅞in. in diameter, which extends the full length of the bridge, and is coupled by means of bevel wheels to the two vertical driving shafts, which are supported by the crane legs driving the steel travelling runners through a further pair of steel bevels. The runners are double flanged, each consisting of a cast iron centre having shrunk upon it a rolled steel tire.

As the lower pairs of bevel gears work with practically no clearance between the engaging teeth, any appreciable wear in a vertical direction of the bearings supporting the weight of these vertical shafts will throw the whole weight of the latter on to the teeth of the bevel wheels. These shafts are therefore supported in large Hoffmann ball bearings, the weight being transmitted from the shaft by means of a steel collar resting against the shoulder turned on the shaft itself. To ensure that the weight of these shafts is taken simultaneously by all balls in the bearings, the ball races are made to rest in spherical washers.

The travelling speed of the crane when carrying its full rated load of 20 tons is 100ft. per minute. In order to facilitate the handling of the crane, Messrs. Heywood have fitted on the travelling motion one of their solenoid-actuated brakes, which operates on a steel drum keyed to the motor spindle.

A platform is provided all round the top of the crane. It is supported by brackets fixed to the main girders, and is protected by a substantial hand rail, which finishes at places on the platform where the two access ladders are arranged. An important feature of this platform is that at one end of the crane it has been made strong enough to bear the weight of any single part of the crab should it be necessary at any time to remove any such part for the purposes of inspection, renewal or repair.

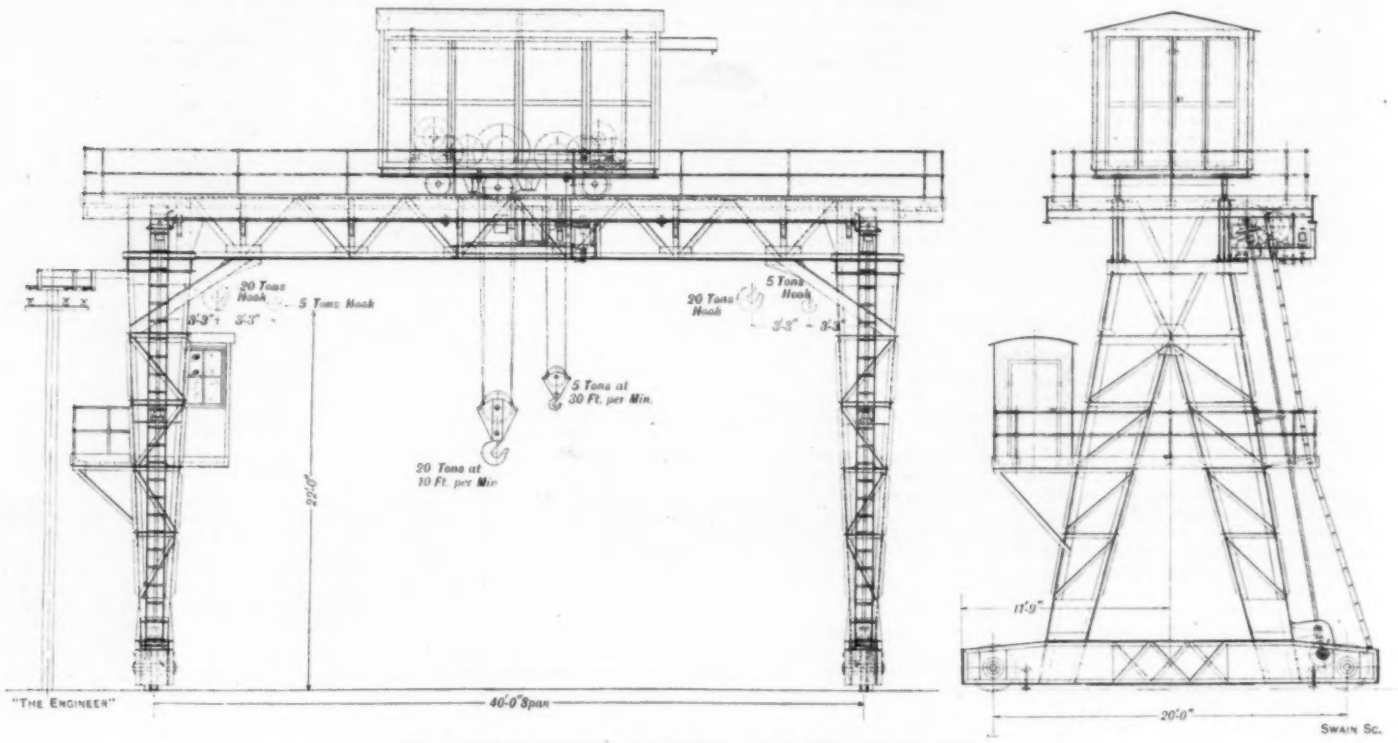
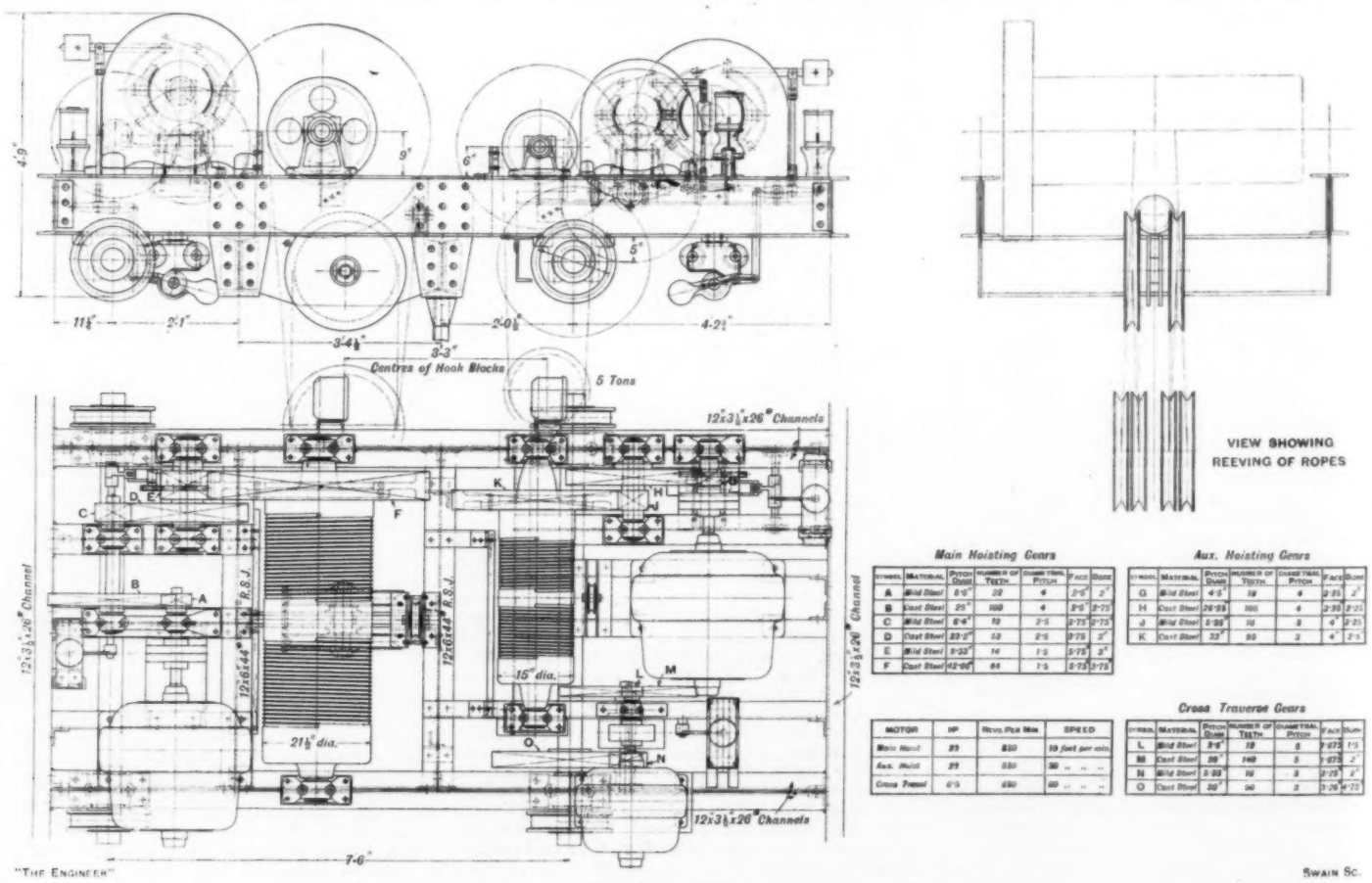


FIG. 1—FRONT AND SIDE ELEVATIONS OF 20-TON GOLIATH CRANE

The main lattice girders which carry the crab are of great strength and are very rigidly connected through the two legs to the two end carriages, the whole being substantially constructed and braced with a view to preventing racking or twisting of the crane when travelling with the fully loaded crab at either extreme limit of its traverse.



Main Hoisting Gears

SYMBOL	MATERIAL	PITCH DIAM.	NUMBER OF TEETH	DIAMETRAL PITCH	FACE	BORE
A	Mild Steel	5'5"	32	6	2'5"	2"
B	Cast Steel	23"	168	4	2'5"	2'75
C	Mild Steel	6'4"	76	2'5	2'75	2'75
D	Cast Steel	23'2"	58	2'5	2'75	3"
E	Mild Steel	5'33"	76	1'5	5'75	3"
F	Cast Steel	42'66"	64	1'5	5'75	2'75

Aux. Hoisting Gears

SYMBOL	MATERIAL	PITCH DIAM.	NUMBER OF TEETH	DIAMETRAL PITCH	FACE	BORE
G	Mild Steel	4'3"	76	6	2'25	2"
H	Cast Steel	26'25"	166	4	2'25	2'25
J	Mild Steel	5'33"	76	3	4"	2'25
K	Cast Steel	33"	99	3	4"	2'5

MOTOR	HP	REVS. PER MIN.	SPEED
Main Hoist	23	850	10 feet per min.
Aux. Hoist	23	850	30 " " "
Cross Travel	6'5	650	60 " " "

Cross Traverse Gears

SYMBOL	MATERIAL	PITCH DIAM.	NUMBER OF TEETH	DIAMETRAL PITCH	FACE	BORE
L	Mild Steel	3'6"	72	3	2'875	1'5
M	Cast Steel	28"	140	3	2'875	2"
N	Mild Steel	5'33"	76	3	2'75	2"
O	Cast Steel	26"	66	3	2'26	1'75

FIG. 2—ARRANGEMENT OF THE CRAB

The crab—which is shown in detail in Fig. 2—consists of a framework built up of rolled steel sections heavily gussetted and riveted together so as to form a rigid structure for sustaining the load and carrying the necessary motors and gearing. It is provided with two entirely separate hoisting motions, each consisting of a barrel driven through spur gearing by an electric motor, each

motion being provided with its own steel wire rope and bottom block.

Each motion is driven by its own 23 brake horse-power motor, the main hoisting motion being capable of lifting the full load of 20 tons at a speed of 10ft. per minute, whilst

The four controllers which operate the four motions of the crane are, of course, fixed in the operator's cabin, which, as is shown in Fig. 3, is carried on one of the legs of the crane, with the ladder and platform provided for easy access. An interesting feature in connection with the

FIG. 3—THE CRANE IN THE RAILWAY YARD AT SMALL HEATH

the auxiliary motion is capable of lifting a load of 5 tons at a speed of 30ft. per minute. The motors are fitted with Heywood's patented series-wound brake operating on a brake drum keyed to the spindle of the motor itself. The motions are fitted with a patented auto-replacement over-

operation of this crane is the employment of the Heywood resistance system, which we illustrate in Figs. 5 and 6. The cabinet containing the resistances is of the enclosed ventilated type. Immediate access can be given to its interior by means of sliding doors, which expose the whole

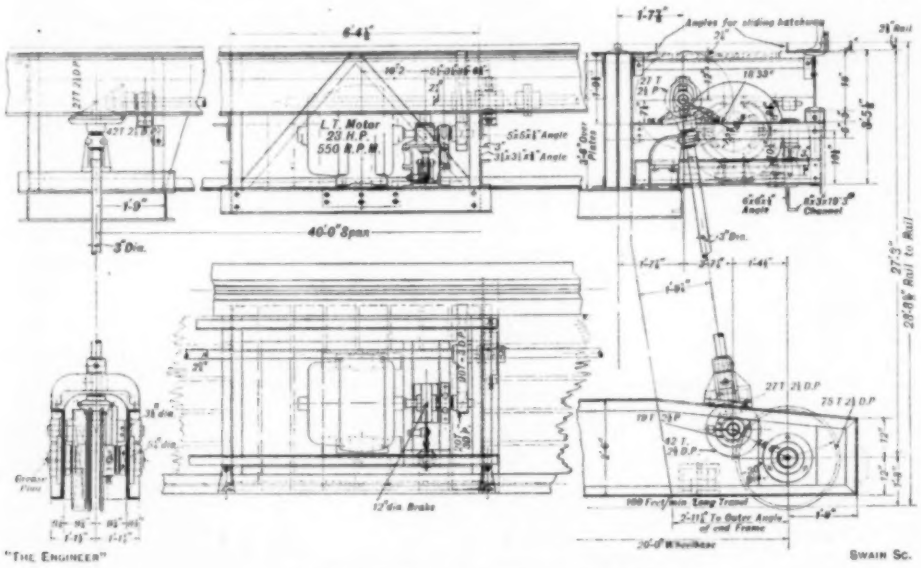


FIG. 4—ARRANGEMENT OF TRAVELLING MECHANISM

winding switch, so that if, through inattention on the part of the operator, the load is hoisted dangerously high, the current supply of the motor is cut off and the brake instantaneously applied. On the hoisting controller being moved over to the lowering side the brake is again lifted and the brake descends, the switch automatically resetting itself against a further overwind.

The cross traverse motion which drives the crab at a full load speed of 60ft. per minute is effected by a 6½ brake horse-power motor, and this motion is fitted with a solenoid operated brake. It will be realised that the use of an automatic brake on this motion calls for great stiffness and rigidity in the legs, and any other attachment to the main bridge, as the sudden stopping of the heavy crab combined with the load possibly hanging on the hook, is liable to cause very serious swaying, unless the accompanying stresses are taken into consideration in the design.

The actual framework of the crab is extended on two sides so as to form a platform. Another feature of this crab is that there is incorporated in the design of the framework a rolled steel joist reaching the full length of the crab and projecting several feet beyond it. Suspended from a trolley running on the bottom flange of this joist is a pair of chain blocks of 1½ tons capacity. This arrangement makes it possible for the heaviest individual article on the crab frame to be picked up, and when the crab itself is brought up to the platform on the crane, the load can be travelled out beyond the crab and lowered on to this platform, which was referred to earlier in this article as having been specially strengthened up to carry the largest single piece on the crab itself. The whole of the crab is enclosed by a substantial framework covered with galvanised corrugated steel sheets, large access doors being provided.

front of the box. It will be observed that each individual porcelain bobbin carrying the resistance wire can readily be removed from the box by disconnecting the supply wires and turning the thumbscrew which holds the bobbin

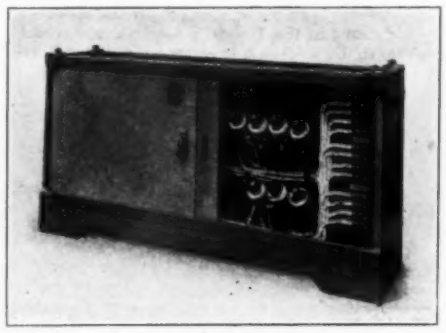


FIG. 5—HEYWOOD RESISTANCE BOX

in position. It will also be noted that, when the sliding doors are open, the whole of the wire of any one bobbin can be easily seen. Fig. 6 shows the separate elements comprising one of the resistances.

Another feature of interest in this crane is the employment of the Heywood patented system of cage wiring. In this connection a spacious cast iron trough—Fig. 7—is run round one side of the cage and a cast iron pipe runs from each controller down to the trough. Large cast iron doors give access to the conductors. The doors are held by two thumbscrews only, which are permanently fixed to the cover, so that they cannot be lost. To prevent the

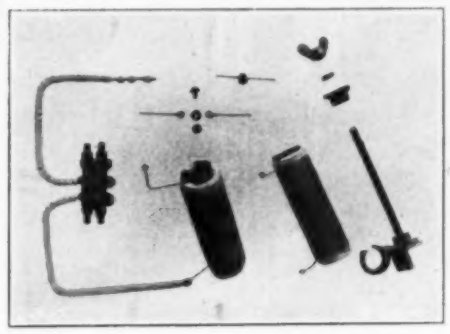


FIG. 6—DETAILS OF RESISTANCES

doors being accidentally pushed over the edge of the cage floor they are secured by chains.

The terminals in the resistance cabinet for each motor are grouped together and clearly marked, the numbers on each terminal corresponding to the numbers on the controller fingers. By picking up any cable in the trough and jerking it slightly, the circuit can be clearly seen at

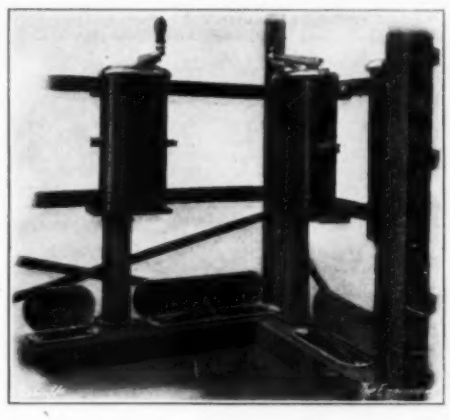


FIG. 7—CAGE-WIRING SYSTEM

once between the controller finger and the particular resistance unit. With this system it is almost impossible for the crane driver to injure the conductors, and he can put his feet in the most comfortable position without the fear of doing any damage.

The total temporary deflection on the crane girders with the crab in the centre of the girders when lifting a test load equal to 25 per cent. overload was $^{7}/_{16}$in.

BOOKS OF REFERENCE

The Highway Engineer's Year Book for 1925, which is published by Sir Isaac Pitman and Sons, Ltd., of Parker-street, Kingsway, London, W.C. 2, price 6s. net, appears in its second year of issue in a somewhat enlarged form, though, in the main, its features remain the same. It is divided into fourteen chapters with the following headings:—"Rock Asphalt and Bituminous Roads"; "Tar, Tar-painting; Bitumen, Bitumen-painting"; "Proprietary Tarry, Bituminous, or Alternative Materials"; "Machinery for Mixing or Applying Tarry or Bituminous Materials, and for Afterwards Gritting"; "Road Rollers and Scarifiers"; "Road Stone and Road Breakers"; "Concrete Roads"; "Concrete Mixers, Layers and Breakers"; "Reinforcement for Concrete Roads"; "Rubber Roadways"; "Street Sweeping, Watering, Cleansing and Gritting"; "Cesspool and Gully Cleaners"; "Motor Wagons—Electric, Petrol, Steam"; and "Miscellaneous Appliances." There is also a classified Directory of Manufacturers. It contains a large amount of information likely to be of use to the highway engineer, and is profusely illustrated, for the most part, apparently, with engravings which have appeared in makers' catalogues. As far as we have been able to check it, the information is quite up to date, but the value of the book would be considerably increased were the index to be more detailed.

FOR heating the rolls of the paper machines in the latest Canadian paper mill about 200,000 lb. of steam will be required per hour, which will be supplied by two 25,000-kilowatt electric steam generators supplemented by four Babcock and Wilcox fuel-heated boilers. A feature of this steam plant is a huge Ruths steam accumulator, 13ft. 6in. in diameter by 65ft. long. It may be said that the electric steam generator is gaining in popularity wherever there are large blocks of electric power going to waste. Although not highly economical they are of great value under the conditions stated. Many pulp and paper mills in Canada have adopted them.

Shipyard Labour Conditions: British and Foreign.

By E. T. GOOD.

A BIG feature of the foreign competition problem is the wide disparity between British and continental —especially German—wages and working hours, whereas before the war the difference was slight. I have gathered some remarkable sets of figures, pre-war and post-war, from which I may give the following without much apology.

Before the war the normal working week in British shipbuilding and related trades was 53 hours in some districts and 54 in others. In Germany they had a 55-hour week, fixed by the Shipyard Agreement of January 1st, 1911. Now we have a 47-hour week against a 54-hour week in the Hamburg, Breslau and Stuttgart districts, as regards the metal group of industries, which includes shipbuilding and engineering. In all the North-Western areas except Hamburg, the working week is one of 57½ hours, and in the Berlin and Mannheim areas 60 hours.

In the matter of wages it is much the same, namely, a wide disparity now compared with little difference before the war. In 1913 the average earnings of all the metal workers in Germany were 1702 marks, or just about 33s. per week, which compared well with our wages. But now German wages are only about half as high as British wages. A schedule prepared by the New York and New Jersey Dry Dock Association gives the following weekly wages of crafts in the shipbuilding industry of Britain, Germany, Holland and the United States, based on 47 hours in this country, 48 in America, 54 in Germany, and 59½ in Holland, in the currency of the United States at the present rate of exchange :—

Craft.	Britain. Dols.	Holland. Dols.	Germany. Dols.	United States. Dols.
Boilermakers	20.45	14.28	8.10	34.56
Smiths	16.22	14.52	8.10	40.28
Machinists	16.22	14.52	8.10	34.56
Carpenters	16.22	15.24	8.10	34.56
Patternmakers	19.04	16.19	8.10	38.40
Joiners	16.22	14.28	8.10	34.56
Electricians	16.22	15.00	8.10	34.56
Labourers	12.69	12.38	6.48	23.00

The *Netherlands Statistical Journal* gives the following earnings of Dutch shipyard and engineering workers for the second half of last year, including premiums and piece-work rates but not overtime pay :—

	Per hour.
Skilled workers	12.88d.
Semi-skilled	11.22d.
Unskilled	9.77d.

The newest German Shipyard Agreement, dated March 1st, 1925, provides for the following time rates per hour :—

Skilled workers	61 to 65 pfs.
Semi-skilled	57 to 61 pfs.
Unskilled	49 to 53 pfs.

(100 pfs. to the mark, and the mark equalling about 1s.)

In March last our Parliamentary Secretary to the Ministry of Labour supplied the following figures and notes on wage rates in German and British shipyards :—

	Great Britain.	Germany.
Skilled :—		
1. Shipwrights	55s. 7d.	
2. Ship joiners	57s. 9d.	31.00 marks, or 30s. 10d.
Mean of 1 and 2	56s. 8d.	
Semi-skilled	No information	29.16 marks, or 29s.
Unskilled	38s. 5d.	25.38 marks, or 25s. 3d.

(Great Britain, nine principal centres ; Germany, mean rates of Hamburg and Stettin.)

NOTES.—1. The German rates were those paid to single men. Supplementary allowances are paid to married men at the rate of 1 pfennig per hour for a wife and 2 pfs. per hour for each child. For a married man with two children this represents an addition of 2s. 8d. per week.

2. The weekly rates for Germany shown in the table were obtained by multiplying the hourly rates by 54 and converting the result into English currency at the rate of 20.10 Reichmarks to the £.

3. For both countries the rates shown in the tables were based on the minimum agreed time rates (per week in Great Britain and per hour in Germany). In both countries rates in excess of this minimum are in practice frequently paid. Furthermore, no allowance was made in respect of extra pay for piecework or for overtime. Consequently a comparison of the average weekly sums actually earned in the two countries might yield different results.

The Berlin Statistical Office has given returns showing average wages per hour in the entire metal group of industries in Germany to have been 71 pfs. in 1924, against 66 pfs. in 1913. It remains to be added that in recent months German food costs have only been 25 per cent. above pre-war—actually only 1 per cent. above pre-war in the middle of last year—against a British index 75 to 80 per cent. up ; that German rents have lately been 33.3 per cent. under the pre-war level, whilst ours have been 40 per cent. higher ; that beer and tobacco are sold in Germany at barely half the prices we pay ; and that rates and taxes, per head of the population, are 300 per cent. higher in Britain than in Germany. The Germans live well on their low wages.

Turning now to other aspects of the labour problem, we have equally striking differences between Britain and the Continent. Whilst here we have forty or fifty separate labour unions in the shipbuilding and engineering industries, with the workers organised in water-tight compartments, involving frequent and costly demarcation disputes, in Holland, Germany, and the other continental countries there are simply metal workers' unions and wood workers' unions, meaning that there is no squabbling about which man is to do a particular piece of metal or wood work. Again, in our country unapprenticed men are condemned for life to unskilled labour, whereas on the Continent the unskilled can move up into the semi-skilled grade, and the semi-skilled can move into the fully skilled grade by their own efforts and abilities. Employers have freedom in the matter of manning machines. Men do what they are competent to do. Skill is cultivated and rewarded. Men rise by merit. Many jobs reserved here for fully apprenticed men are performed on the Continent by semi-skilled workers. Again, continental mechanics do not expect so many labourers to carry their tools and materials about for them as our skilled men insist upon. All these points add to the disparity between British and foreign costs.

Institution of Electrical Engineers' Summer Meeting.

No. I.

THE summer meeting of the Institution of Electrical Engineers commenced on Tuesday last in Birmingham, the headquarters of the South Midland Centre, and it will be brought to a close this evening at the Edgbaston Botanical Gardens. Within the area which the South Midland Centre of the Institution embraces there is much of electrical interest—so much, in fact, that at the conclusion of the outing a great deal of the ground will be left untraversed. Important works, such as those of the Brush Electrical Engineering Company at Loughborough, the Electrical Construction Company at Wolverhampton, the Siemens Works of the English Electric Company, and those of other notable electrical firms within the area of the South Midland Centre could not be included in the programme, which, however, was quite a good one, especially from a social point of view. Birmingham is, of course, a place where electricity has made very rapid progress and where the members of the Institution might easily have spent the whole of the time allotted to the summer meeting in exploring works and central stations, but though, of course, other places of interest were visited, the only Birmingham electrical manufacturing works that were inspected were those of the General Electric Company at Witton. Naturally, the Birmingham electric supply undertaking claimed attention, and although it has perhaps been given more publicity than most other supply systems in the United Kingdom, the members appeared to be thoroughly interested in everything that was brought to their notice. There are two features relating to the use of electricity in Birmingham which are noteworthy. In the first place, the distribution of electricity in the outlying residential districts is largely carried out in the form of direct current in preference to 25-cycle alternating current, conversion being effected in a number of mercury arc rectifier sub-stations, a good example of which is that at Longbridge, which was visited. Secondly an experiment in heavy railless traction has been undertaken. As the track belonging to one of the busiest suburban routes got into a very bad state during the war it was decided to remove it altogether and to employ double-deck trackless cars, which resemble ordinary tramcars, and which have proved a complete success.

On Tuesday morning a visit was paid to the Birmingham Corporation's Princes-street station at Nechells, where extensions are in progress. When complete, the ultimate capacity of the plant will be 90,000 kilowatts, or 110,000 kilowatts on overload, and there will be seven 15,000-kilowatt sets, one serving as a spare. At present, the completed section of the station has a capacity of 60,000 kilowatts, or 73,500 kilowatts on overload, there being four 15,000-kilowatt machines and boiler plant with a steaming capacity sufficient for the maximum overload. The station was built in sections and extended from time to time, the final extension now being undertaken. Views of the existing turbine room, part of the boiler-house, &c., are given in the engravings on page 654. When complete and equipped with its seven 15,000-kilowatt sets, the turbine room will be 525ft. long. The boiler-house is arranged in bays at right angles to the turbine room, each bay accommodating six boilers. When completed, the boiler-house will be 526ft. long, and it will contain thirty-one boilers, together with auxiliary plant.

Designed to deal with coal arriving in railway trucks or barges, reaching the station by way of the canal, the coal-handling plant is of considerable interest. On arrival, the railway trucks are tipped bodily by means of wagon tipplers into grabbing pits, there being one pit for each boiler-house bay, containing six boilers. From these pits, or from the canal barges, the coal is removed by means of grabs operated from overhead electrically driven telphers, which, after raising the grab to the required height, convey the coal into the boiler-house and drop it into the overhead bunkers, from which it passes down inclined chutes in the ordinary way. From ash hoppers below each boiler the ashes are collected by means of steel trucks hauled by electric locomotives, and subsequently they are elevated and tipped into an overhead ash bunker, from which they can be discharged into railway trucks or canal barges.

At present there are twenty-one land marine type water-tube boilers, each equipped with a superheater, steel tube economiser and chain grate stoker. Six additional boilers now being installed are to be fired with pulverised coal. The working pressure is 325 lb. per square inch, and the steam is superheated to a total temperature of 700 deg. Fah. Two of the new boilers are fitted with air heaters in lieu of economisers. When fired with fuel having a calorific value of 9000 B.Th.U. the maximum evaporative capacity of each boiler is 42,000 lb. of water per hour, but for the final extension to the station it is proposed to install four boilers, each capable of evaporating 150,000 lb. of water per hour when fired with pulverised coal. All the boilers are arranged to work with induced and forced draught, which is supplied by large motor-driven fans, one steel chimney of the Pratt type being provided for each pair of boilers.

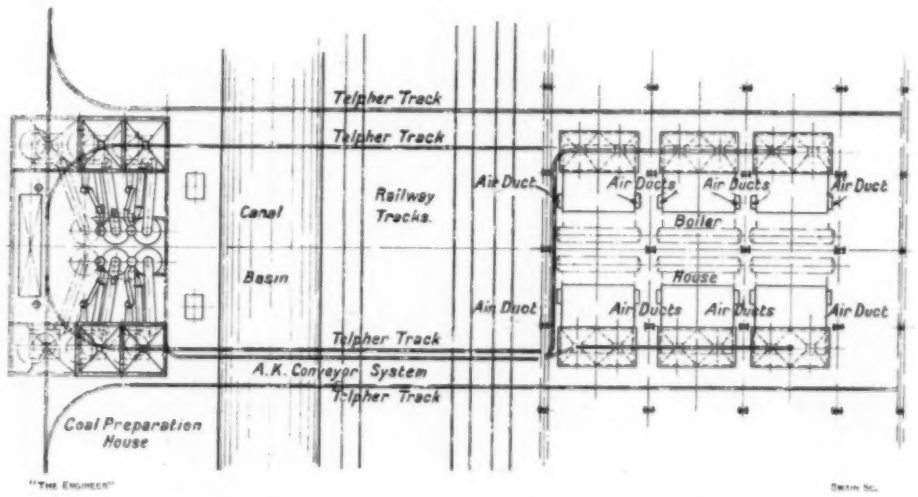


FIG. 1—ARRANGEMENT OF COAL PULVERISING PLANT AND BOILERS

There are eight steam-driven boiler feed pumps, four turbine-operated and four reciprocating pumps, the capacity of the former being 25,000 gallons per hour and that of the latter 10,000 gallons per hour. All these pumps are placed on a gallery in the boiler-house. On this gallery there are also six evaporators, each having a capacity of 7000 lb. per hour, for providing pure make-up water for the supply to the boilers. A closed circuit system has been adopted for the feed-water supply in order to eliminate internal corrosion, and a vacuum is maintained in the feed tanks with a view to removing as far as possible air from the water before it enters the boilers and economisers. A fifth turbo-alternator, with a normal capacity of 15,000 kilowatts and an overload capacity of from 18,000 to 18,750 kilowatts, is in the course of erection. The stop valve steam pressure is 300 lb. per square inch and the vacuum in the condensers 28in., with the barometer at 30in. Each generating set runs at 1500 revolutions per minute, and generates three-phase alternating current at a pressure of 5500 volts between phases and at a frequency of 25 cycles per second. On each alternator shaft there is in addition to the exciter a 250-kilowatt shunt-wound direct-current generator, which supplies the current for driving the auxiliary plant, associated with each

turbo-alternator. Two new sets corresponding with those already in operation are on order for the completion of the station.

Each surface condenser for the turbines is designed to deal with 198,000 lb. of steam per hour and to maintain a vacuum of 28in. when supplied with circulating water at a temperature of 75 deg. Fah. Thirty-five natural-draught chimney-type cooling towers have been erected, capable of dealing collectively with 6,000,000 gallons of water per hour and of reducing the temperature of that quantity of water from 92 deg. to 75 deg. Fah. when the atmospheric temperature is 55 deg. Fah. Ten additional towers are now on order, so that the complete battery will ultimately consist of forty-five towers. The towers are erected over large ferro-concrete ponds, which can be subdivided into sections by means of penstocks. After passing through the condensers the circulating water is carried to the towers through duplicate main discharge pipes, mounted above the ponds and branch pipes and valves distribute the water among the various towers, the circulating water used being filtered sewage effluent, obtained from a large block of filter beds belonging to the Birmingham, Tame and Rea District Drainage Board adjacent to the generating station.

All the 5500-volt switchgear is metal-clad cellular gear, and is electrically controlled from panels in the control room—shown on page 654. Only the main switches for controlling the turbo-alternators, the groups of feeders and the main step-up transformers are connected to the main bus-bars, which are in duplicate. The outgoing 5000-volt feeders are controlled by similar switches of smaller capacity, which connect these feeders to separate group feeder bus-bars, which, in turn, are connected to the main bus-bars through current-limiting reactances, these feeder switches also being electrically operated from separate panels in the control room, which also contains switchboards for controlling the works low-tension direct-current and alternating-current supplies for lighting and various motors about the works.

A storage battery with a capacity of 1000 ampère-hours has also been installed for operating the extra high-tension switchgear and for a portion of the station lighting. Five banks of transformers, each rated at 10,000 kilowatts, have been installed for raising the generator pressure from 5500 volts to 33,000 volts for transmission to sub-stations in the more remote parts of the city. Each of these transformer banks consists of three single-phase forced oil-cooled transformers installed in a separate fireproof brick cubicle forming part of the switch-house building.

International Combustion, Ltd., and the Vickers-Spearing Boiler Company, Ltd., are the joint contractors for the new steam-raising plant, which consists of six pulverised coal-fired Vickers-Spearing boilers, each having a heating surface of 5400 square feet. The general lay-out of the boilers is shown in Fig. 1, four of the boilers, as we have already said, being fitted with steel tube economisers, and the remaining two with air preheaters. The normal evaporation of each boiler is 35,000 lb. per hour, with an overload capacity of 42,000 lb. per hour. As shown in Fig. 1, the central system of pulverising has been adopted, and the pulverising house, which is quite separate from the boiler-house, contains the following equipment:—Four raw coal bunkers, four rotary steam driers, four Raymond pulverisers, two pulverised fuel bunkers, and two Fuller-Kinyon pulverised fuel pumps. Each raw coal bunker is capable of holding 34 tons of coal, which is sufficient for about six hours' continuous running on full load.

As received, the coal contains from 12 to 20 per cent. of total moisture, and has a calorific value when dry of 10,000 to 10,700 B.Th.U. per lb. The chutes on the bunkers are fitted with regulating valves, by means of which the raw coal is fed to the driers, which are of the rotary steam-heated type. Vapour formed in the driers is carried off by hot air circulated by a fan which discharges into a cyclone separator, and any coal dust picked up by the air in passing through the drier is trapped and returned to the system. On its way to the pulveriser the dried coal passes over a magnetic separator, which removes any tramp iron or steel from the coal, and so eliminates any possibility of damaging the mills. The four six-roller "low side" Raymond pulverisers are each capable of pulverising 6 tons of coal per hour, so that 85 per cent. will pass through a 200-mesh sieve, 95 per cent. through a 100-mesh sieve and no coal at all will be left in a 40-mesh sieve.

Each pulveriser is driven by a 75 horse-power constant-speed three-phase ventilated-type motor, which is connected to the horizontal driving shaft of the mill through a flexible coupling. The exhauster fan is driven by a 45 horse-power motor. Separation of the pulverised fuel and elevation to the pulverised fuel storage bunkers is carried out by a current of air, continuously circulated in a duct system by the exhauster fan. The air enters the base of the pulveriser, picks up the lighter particles of coal and discharges into a cyclone separator situated above the level of the pulverised coal bunkers. The powdered coal thrown out into the cyclone passes through an automatic flap valve into the storage bunkers, whilst the air returns to the base of the pulveriser for re-circulation. For all intents and purposes the air separating and conveying system is closed, and dust nuisance is therefore avoided. An automatic release valve is fitted to an atmospheric vent on the discharge side of the exhauster fan to avoid the possibility of a pressure building up in the cyclone or duct system.

The distance between the pulveriser-house and the boiler-house is about 120ft., and the two are separated by the canal basin, the coal being conveyed to the bins in the boiler-house by means of two electrically driven Fuller-Kinyon pumps. An air compressing plant operates in conjunction with the Fuller-Kinyon pumps, and supplies air to the pulverised fuel lines at a normal pressure of 40 lb. per square inch, but for cleaning purposes or for the removal of blockages, this pressure may be increased. The fuel pipes between the pulveriser-house and the boiler-house are 5in. in diameter and 270ft. long, with a vertical lift of 60ft.

Over each boiler is a pulverised fuel bin, with a capacity sufficient to meet emergencies. The supply of fuel is controlled by a series of electro-pneumatic valves operated by push buttons in the pulveriser-house, near the Fuller-Kinyon pumps, and by these means any particular bin may be filled at will, each bin being fitted with a coal level indicator. The pulverised fuel feeding gear, the burners and the combustion chamber are all of the well-known "Lopulco" type. Each pulverised fuel bin terminates in a hopper, at the bottom of which there are four fuel feeders grouped in pairs. The feeders are of the screw type, designed to avoid all possibility of clogging or packing. The pulverised fuel drops on to the screws by gravity, and is propelled towards the discharge end of the feeder, where it meets the primary air, and the two are intimately mixed by a rotating paddle. The primary air, which constitutes about 15 per cent. of the total air required for combustion, is supplied at a pressure of 16in. W.G. With the fuel, this air forms a "mechanical gas," which can easily be conveyed by means of the pipe line to the burner. The screws are driven through worm gear by a variable speed electric motor, giving a speed range of 3 to 1, and each screw is fitted with a clutch, a combination which makes the system extremely flexible and which enables any variations in the demand for steam to be met with the least possible delay. To prevent the fuel packing as the result of the condensation of moisture in the fuel line between the feeder and the burner, the primary air is slightly preheated.

Each furnace is equipped with four fish-tail burners, which are situated in the arch, and they discharge downwards, the burners giving a flat-divergent stream of fuel in which each particle of coal is immediately brought into intimate contact with the combustion air. The burners are kept cool by a current of cold air, induced through damper-controlled passages surrounding the burner. The steel-cased furnaces have hollow walls through which the secondary air circulates before entering the furnace, the brickwork being built up in sections on refractory holding tiles, so as to permit of free expansion and contraction with change in temperature. The arch is of the Liptak flat suspended type.

The furnace is equipped with a water screen and a water-cooled back wall, composed of tubes 4in. in diameter and spaced 13½in. apart, the screen and back wall forming an integral part of the boiler circulating system, and while serving to prevent fusing of the arch and slagging of the brickwork, add materially to the evaporative capacity of the boiler. Behind the water-cooled back wall is a Foster radiant heat superheater, having 40 square feet of heating surface, which supplements the convection superheater and is responsible for the addition of at least 100 deg. Fah. of superheat. The secondary air enters the furnace through eighty-four ports, which are in front of the wall of the furnace and are arranged in groups and are controlled by independent dampers. Combustion is therefore always under control, and adjustment can be made so that the whole volume of the combustion chamber above the screen is effectively utilised and the maximum efficiency developed under all conditions of load. The guaranteed thermal efficiency based on the net lower calorific value of the fuel is as follows:—

	Normal rating. Per cent.	Overload rating. Per cent.
Economiser boilers	91.2	90.4
Air preheater boilers	89.8	88.8

The guaranteed CO_2 content of the flue gas leaving the boilers at normal load and overload is 14 per cent.

SIXTY YEARS AGO.

SIXTY years ago a considerable volume of correspondence was being published in our columns regarding the hours and conditions of work of the engineering draughtsman. Nearly all our correspondents supported our own view that the draughtsman's hours at that time were in general much too long, and that a reduction of them would have the effect of improving and increasing the output. In our issue of June 9th, 1865, however, a correspondent, signing himself "Valentine," opposed the general opinion. He was then, he said, upwards of seventy-one years of age, and although he had been a draughtsman all his life no one, he thought, could have enjoyed better health. He served his apprenticeship in the drawing-office of a London engineer, finishing his time in May, 1815. During his apprenticeship his working hours were six to six, or, when busy, from six to eight, for which he was paid for seven days. In 1819 he left London and continued his work as a draughtsman in the country without finding that the long hours in any way impaired his health. Round about 1847 he returned to London, and was re-engaged by his first firm, the hours then being 8.30 a.m. to 5.30 p.m. He concluded that the draughtsmen of the day were frightened of work. They now thought an eight-hours day too long, whereas formerly there were no complaints when the working day extended to ten or ten and a-half hours. In a footnote, we congratulated our correspondent on the possession of an excellent constitution, and hailed him as possibly the oldest draughtsman in England. . . . On another page in the same issue we printed the opinion of a French senator, a member of the jury for the International Exhibition of 1862 on English taste and art. Up to recent times, he said, the English had not been very remarkable for taste, and good taste was wanting in their industry. He was now, however, impressed and frightened by the progress being made in works of good taste, for he saw in that progress a challenge to the premier position of France in industrial arts. The advance being made in England was, he held, the outcome of the movement in art education begun by the establishment of the South Kensington Museum. Strangely enough, in an immediately succeeding paragraph, Ruskin, that apostle of good taste, was taken to task for his criticism of Blackfriars Bridge across the Thames, then but recently erected. That bridge it was admitted—and few to-day looking at its structure of wrought iron, cast iron, granite and Portland stone, will dispute the assertion—was very ugly. But the improvements suggested by Ruskin, it was pointed out, would have completely interfered with the structural principle of the bridge, and in other respects would have constituted a sham of as great an order as the critic himself had ever condemned.

The Gleno Dam: Another Report.

FOR most engineers the discussions of the failure of the Gleno dam have probably passed the stage at which a definite opinion as to the cause of the failure has been formed; but the criticisms of its design and of the methods employed in building it, and the strenuous efforts of the band of experts who have undertaken the defence of the whole affair in the owners' interests continue to furnish matter for thought as regards the location, planning and building of dams of this class, or for gorges like that of the Gleno. No doubt most engineers will agree with the conclusions that the dam should not have been curved in plan, that it should not have been provided with the two heavy piers, and that the design was somewhat on the lean side. If the Gleno gorge is one in which the normal rock movements of expansion, contraction, cleavage and slip are unusually active, those three considerations gain in force, and it must be remembered that the movements which have led in so many cases to the strewing of the bottom of a gorge with large blocks of rock did not cease when we began to build dams in such places. A dam is not exactly fitted into an unaltering gap, though in some cases we may see safety for hundreds of years ahead. Rock movements matter least in the case of a mass gravity dam, more in the case of a multiple arch dam, and more still with a single pure arch dam. Perhaps they are most serious when the dam is one of many arches and is curved in plan. These considerations, if they were especially important at the site of the Gleno dam, should have received attention before it was built, and the defenders of the design in contending as they now do that rock movements are notably active in the Gleno gorge, are "wading in deeper"; and if they are right as to the facts, those who approved officially of the design must also take their chances in these deeper waters.

Ing. Professor Mario Baroni and the engineers—Srs. Luigi Kambo, Urbano Margoli, and Ugo Granzotto—have issued an appendix to their "Memoria Tecnica: La Diga del Gleno," and the most interesting feature of this appendix, dated April 15th, 1925, is the presentment of evidence supported by photographs and purporting to show that there is marked progressive fissuring of the rock in the Gleno gorge. The report also contains matter relating to specific criticisms contained in the report of the official investigation of the failure, and the authors seek to rebut the findings regarding insufficient excavation of foundations, too low proportions of cement, "chaotic" building, and other defects in design or construction. Reproductions of photographs are used to support the authors' contentions, but while some, as far as they go, suggest good work, the views of the dam are such as to create an immediate impression of uneasiness, supposing them to be seen for the first time by an engineer who knew nothing about the dam or the failure.

The authors come to a remarkable conclusion regarding the failures of the following dams—Puentes, Habra, Cheurfas, Bouzey, Austin (Texas), Austin (Colorado), Stony River, and Johnston—in all of which cases the failure may be attributed to "defects in the ground forming the foundations" ("difetti del terreno di fondazione"). Apart from this assertion, the bearing of the failures on the failure of the Gleno dam must in some of these cases be slight indeed.

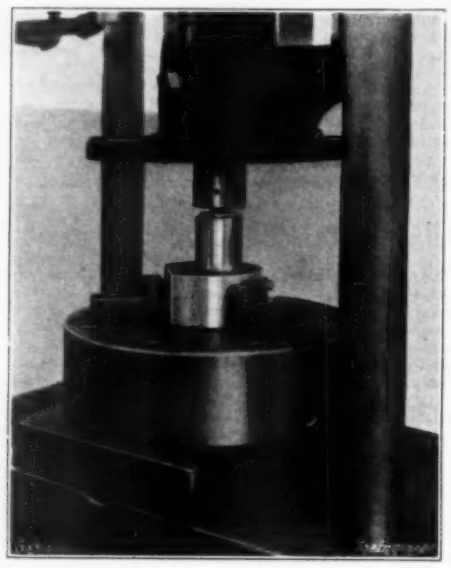
In support of their contention that the stability of the dam was imperilled by the nature and behaviour of the rocks, the authors have reproduced some very interesting photographs, and have included in their "appendix" reports by Professor Paolo Vinassa de Regny and Professor Mario Felici. If these professors are right in their opinions as to the progressive fissuring of the rock and its nature and qualities as the foundation of a dam on the bottom and the sides of a gorge, it seems to be a natural deduction that the type of dam, apart from its actual form was ill-chosen, and that the Gleno gorge is a site on which a dam should be of the mass gravity type, and built, as a whole, deeply into the bottom and sides of the gorge.

The opinions of these investigators must needs be treated with respect, and there may therefore be yet another sufficient cause of failure to be added to the already formidable list.

The Strength of a Chuck.

A SHORT time ago Alfred Herbert, Ltd., of Coventry, decided to make a test in order to discover what force would be required to burst one of their well-known "Coventry" concentric chucks. For the purpose of the test, a 12in. three-jaw chuck was taken from stock, and with the aid of the device shown in the accompanying engraving, was tested in a hydraulic press capable of applying a total load of 65 tons. The device consists of a body containing two plungers, one vertical and the other horizontal. The bores in which the plungers slide are connected by a passage charged with oil. With the device arranged as shown, the horizontal plunger bears against one of the chuck jaws, while the body makes contact with the two other jaws. The plungers being of equal area, the load applied by the press to the vertical plunger is thus distributed equally on to the three jaws.

On carrying out the test, Messrs. Herbert inform us, it was found that the chuck withstood the full load of 65 tons without suffering damage, and that subsequently it could be operated as satisfactorily as before the test. A similar size of chuck by another maker was then subjected to the same test. At a load of 13 tons, Messrs. Herbert state, this chuck failed, all the threads engaging with the scroll being stripped off the jaws.



HERBERT CHUCK UNDER TEST

On inquiry, we find that in the design of Coventry chuck tested, the multiplying factors are such that a pull of 1 cwt. exerted on the standard wrench supplied with the chuck would, neglecting frictional losses, produce a force of 14 tons on the jaws. This figure is so small compared with the load of 65 tons which the chuck withstood under test that it might almost be argued that the strength of the Coventry chuck is excessive. It must be remembered, however, that a chuck is liable to misuse. At times extra leverage is sought by the workman and for that purpose he will slip a piece of pipe over the wrench handle. Again, he may seek to apply extra force to the extended handle by placing his foot against some part of the lathe, after the manner of one rowing with his feet against a stretcher. A strong man, Messrs. Herbert contend, might in this way exert a pull of 200 lb., which, combined with the extra leverage given by the piece of pipe, would result in a load on the jaws of about 50 tons. It follows, therefore, that under even severe and almost unfair usage the Coventry chuck possesses a good margin of safety.

WARSHIP LAUNCHINGS IN 1925.

THE amount of naval tonnage launched during 1925 promises to exceed by a considerable margin the total of any year since the war. At the head of the list stand the battleships Nelson and Rodney, each of 35,000 tons. It is possible that one or more of the five "County" cruisers, of 10,000 tons, may go afloat before the end of the year, though that event is doubtful. Two destroyers and one submarine may also be launched for the British Navy. In Japan the 27,000-ton aircraft carrier Akagi left the ways in April, and in the same month the 7100-ton cruiser Kako also took the water, a sister-ship, Furutaka, having been launched in February, and a smaller cruiser, the 5570-ton Naka, in March. Besides these ships, a number of Japanese destroyers and submarines have been, and are to be, launched during the current year. The aircraft carrier Saratoga, of 33,000 tons, went afloat for the United States Navy in April, and a sister ship, the Lexington, will follow her in a few weeks' time. Two French 10,000-ton cruisers, Duquesne and Tourville, are scheduled for launching in the late autumn, while hardly a month goes by without witnessing the launch of a new French destroyer or submarine. Italy may find it possible to put afloat one or both of her 10,000-ton cruisers, Trento and Trieste, this year, together with several destroyers and underwater craft. Germany launched the cruiser Emden, of 6000 tons, in January, in which month also the Spanish cruiser Principe Alfonso, of 7850 tons, took the water, leaving a sister ship still on the stocks. The combined displacement of all these new vessels is well over 250,000 tons, and the actual total for the year may be nearly 300,000 tons.

Combined Electric Motor and Pump.

AN extremely simple pumping set, called the "Mopump," comprising an electric motor with a centrifugal pump secured directly to the body, is being introduced by Rhodes, Brydon and Youatt, Ltd., of Stockport. Being designed as a unit the usual bed-plate, pedestal, projecting spindle and coupling are eliminated, as will be observed from the illustration—Fig. 1. The pump body is supported from the one of the covers of the motor, and impeller is mounted on an extension of the armature shaft, as shown in the sectional illustration—Fig. 2—

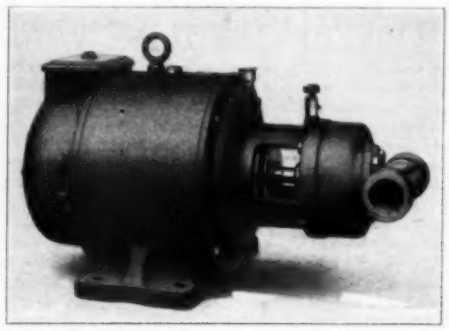


FIG. 1—THE "MOPUMP"

making dismantling for examination and renewals a simple operation, while effectively preventing water from reaching the motor. The motor shaft A is reduced in diameter at the driving end on a length sufficient to accommodate the sleeve-like extension D of the impeller C. It will be seen that the shaft does not extend right through the impeller, but terminates in a blind hole, so that no water can pass along the shaft, and thus cause possible rusting up. The impeller is located and held in position on the shaft, and the drive is taken through an accurately fitting pin E, which projects slightly through both sides of the impeller sleeve, and is prevented from displacement by means of a spring ring or clip F. The pump casing G, with the stuffing-box H for the sleeve D, is secured, as shown, to the end cover J of the motor, in which the ball bearing B is supported. K is the inlet and L the delivery branch of the pump. The pump can be easily dismantled by removing the nuts from the studs M which hold the cover and the body together, slacking the stuffing-box nut, and removing the pin E.

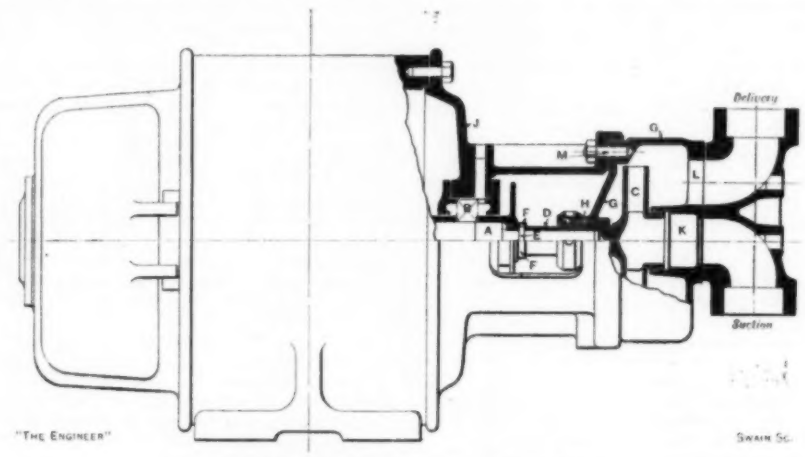


FIG. 2—ARRANGEMENT OF THE "MOPUMP"

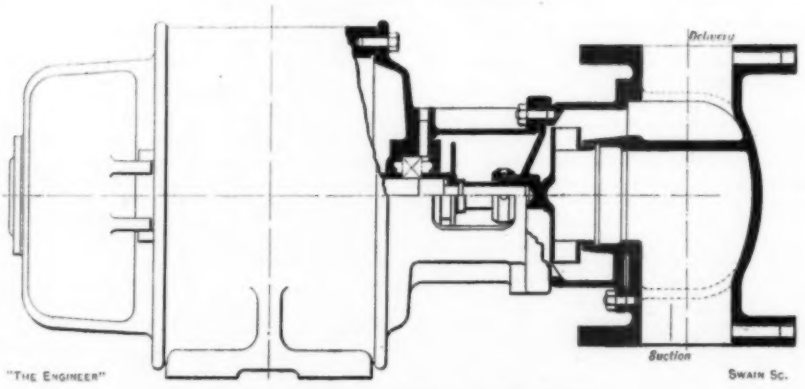


FIG. 3—ARRANGEMENT OF THE "AXCEL MOPUMP"

The pump is made in five sizes, from ¾in. giving a maximum delivery of 500 gallons per hour to 3in. giving 15,000 gallons per hour, with either alternating-current or direct-current motors. In the smaller sizes the pump body is made of gun-metal, and in the 2in. and 3in. sizes of cast iron. The impeller is in all cases made of phosphor bronze.

A modification of this pump, called the "Axcel Mopump"—illustrated in Fig. 3—has been designed specially for use as a booster in hot water heating systems, when only a low pressure head is required to effect the necessary circulation, and when additional pressure is only required at intervals. The design of this pump is such as to give a clear way through, equal in area to that of a 3in. pipe, and the pump branches are arranged so that the pump may be inserted in a straight line of heating pipe. As the velocity due to thermo-syphon circulation is low in any case, it will be appreciated that the actual head loss through the pump is almost negligible when it is out of action.

The applications for such a handy pumping set are obviously very numerous, and by reason of the compactness of its design it is specially suitable for portable purposes. One pump supplied to a provision factory has demonstrated its adaptability to deal with hot water very efficiently. In this case, the pump is, we are informed, working daily with water at 200 deg. Fah., with not more than 18in. head actual above the pump.

The Twin-screw Ferry Boat Kathleen.

THE twin-screw ferry boat Kathleen—shown in the accompanying illustration—sailed for Lagos from Southampton on May 21st. She was built by John I. Thornycroft, Ltd., of Woolston Works, Southampton, to the order of the Crown Agents for the Colonies, under the supervision of Messrs. Wells and Kemp, consulting naval architects and marine engineers, St. Stephen's House, Westminster. The Kathleen is a twin-screw steel ferry boat, with upper and lower decks, and is designed to carry a total of 800 passengers, of which 435 can be accommodated on the upper deck of the boat. Some of the principal dimensions of the ship and her machinery are given in the following summary :—

Hull Particulars.

Length between perpendiculars	123ft. 9in.
Breadth	25ft.
Depth	9ft.
Draught fully loaded	5ft. 6in.
Speed fully loaded	11 knots

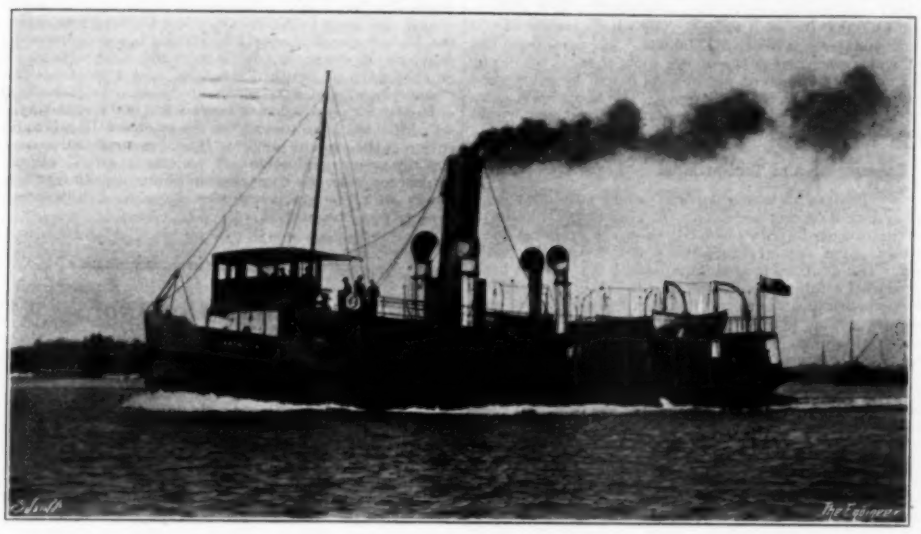
Propelling Machinery.

Type	Twin compound, surface condensing
Diameter of cylinders—	
High-pressure	11½in.
Low-pressure	23½in.
Stroke	16in.
Total output	700 I.H.P.
Normal speed	200 revs. per min.
Working pressure	150 lb. per sq. in.

The vessel was built to Lloyd's requirements, and is fitted with water-tight bulkheads in the forepeak, and forward stokehold, the after engine-room and the after peak, while a screen bulkhead with a door on either side of it is provided between the engine-room and the stokehold. Access to the fore and after holds and peaks is given through water-tight hatches and scuttles on the main deck. From the illustration which we reproduce it will be noted that the steering position is situated forward at upper deck level. It is sheltered by a teak screen fitted on deep steel coamings, and it runs the full width of the deck, being open at the after end. Sliding windows are fitted, and an overhead canopy of Oregon pine gives top protection. The steering wheel and helm indicator are connected to the steam steering engine by shafting in the usual way. A single plate type of rudder is fitted, and the rudder quadrant, which is placed on deck, is connected to the steering engine by means of chains and rods fitted

THE TWIN-SCREW FERRY BOAT KATHLEEN

JOHN I. THORNYCROFT AND CO., LTD., SOUTHAMPTON, BUILDERS AND ENGINEERS



with buffer springs. The steering engine and the windlass were supplied by Clarke, Chapman and Co., Ltd., of Gateshead. It will be seen that stanchions for awnings are provided on the upper deck. Two lifeboats are carried, and for the voyage out, temporary accommodation was arranged in the main deck houses, which fittings will be removed when the vessel arrives at her destination. A galley about 8ft. by 5ft. is provided, and a fresh water tank of approximately 400 gallons capacity is placed in the hold below the galley space.

The main propelling machinery consists of two sets of compound engines, with an independent surface condensing plant. The engine cylinder dimensions and the piston stroke is given in the table above. A pear-shaped condenser is fitted. It has a large surface suitable for working under tropical conditions. All auxiliaries are worked independently of the main propelling machinery, and they include a Weir dual type air pump, a pair of Weir simplex feed pumps, one Paul centrifugal circulating water pump, a direct-acting fire and bilge pump by Weir, and a Paul engine-driven fan for assisting the boiler draught.

Two boilers of the return tube type with a length of 10ft. 6in. and an internal diameter of 10ft. 9in., and designed for a working pressure of 150 lb. per square inch are installed. The machinery spaces are ventilated by cowls, which can be swivelled from the engine-room and stokehold respectively, and the stokehold trunks are arranged to take ash hoists. We learn that the trials of the ship were satisfactorily carried out in the presence of the consulting engineers and of the representative of the Crown Agents for the Colonies.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Situation.

THOUGH most of the works in the Midlands and Staffordshire have now resumed operations there is very little new business forthcoming, and the already scanty order books are becoming thinner. In these circumstances demands upon the producers of iron and steel are very small, and the general market conditions are dull. There are to be found few signs of impending improvement in the situation in the near future, and output is being kept down to a low standard. Staffordshire ironmasters have reduced their basis rates for bar iron, and many steel masters, eager to secure business, continue to "cut" the recognised quotations. Buyers are not tempted, however, to cover more than immediate needs. This hand-to-mouth buying is the dominant feature of the general position, and is symptomatic of the times and the lack of stability. The general trend of trade is regarded as being far from encouraging, and industrialists here, in common with those in other districts, find the present period most trying.

Staffordshire Iron Prices.

The new business forthcoming in the Staffordshire finished iron trade is chiefly under the head of high grade bars for engineering work. It is as yet too early to tell whether demand will be stimulated as the result of the action of the South Staffordshire Ironmasters' Association in reducing the price of marked bars 10s. per ton, making the basis price £14 10s. per ton net cash at makers' works. Bar iron prices have been generally readjusted. For some weeks past there has been a puzzling disparity of prices in the various districts, and the freedom exercised by unassociated manufacturers has further perplexed an already complicated situation. Following the lead of Scotland, prices were reduced in the Lancashire district. Crown bars were lowered to £12, and common bars to £10 15s. Yorkshire millowners have thus far refused to budge. They put up their Crown bars a little while ago to £13 and there they have kept them. The Staffordshire Association, after discussing the situation, resolved to reduce Crown and common bars by 7s. 6d. per ton. This leaves Crown bars 7s. 6d. above the Lancashire and 12s. 6d. below the Yorkshire basis. Staffordshire common bars are now 12s. 6d. above the Lancashire rate. What is principally hoped for from the arrangement is the strengthening of trade solidarity in the district. Business is very meagre, especially in nut and bolt qualities, practically all the orders going to the Continent at round about £4 per ton lower than local producers can entertain.

Galvanised Sheets.

The galvanised sheet trade continues one of the most favoured departments, orders being fairly plentiful at £16 10s., with activity assured throughout the summer. The tin-plate trade shows a little improvement, following the lower prices adopted since the regulation of rates was formally abandoned. The outlook in that department is considered more healthy.

Steel.

Steel orders are practically all for constructional purposes. They maintain a fair volume as compared with the pre-war period, but are much below the capacities of the extended plants. Merchants report that the increased interest noticed a week ago is maintained, a fair amount of inquiry coming forward under most heads. Business, however, for the most part is restricted to small lots, prices being weak in most departments, and justifying a cautious policy. The steel trade, however, needs very much more than orders for constructional material to keep the mills employed, and while more interest is shown by buyers a good deal of the new work is finding its way to the Continent, where lower prices than ever are being quoted. Germany has been vigorously canvassing the British market lately, agents of Krupps visiting Birmingham with low offers of semi-finished steel. Wire rods have been sold at prices much below anything native steel makers can accept. Special efforts are being made to capture the business in heavy forgings, in connection with the few shipbuilding orders lately given out. Plates for constructional work have now settled generally to £9, a fall of 5s. per ton. Angles and sections are also somewhat cheaper, though quotations are maintained at £8 7s. 6d. Small steel bars have been lowered by some makers, to secure much wanted orders, somewhat below the £8 15s. figure. Native billets continue steady at £6 15s., and Belgians are at about £6 2s. 6d. delivered here. The unsatisfactory position of the steel trade as regards volume of business and the prices which consumers are prepared to pay reacts upon the market for basic.

Scrap.

Scrap steel is nearly unsaleable, despite the very low prices, which are considered unusually attractive.

Raw Iron.

There has been no change in the pig iron situation during the week. Last week's minimum prices have become general. Some furnacemen on 'Change in Birmingham are quoting rather more than £3 7s. 6d. for Northamptonshire No. 3 and £3 12s. 6d. for Derbyshire, but those figures marked the limits to which buyers were prepared to go. There is still no assurance of stability, however. Blast-furnace coke is gradually becoming cheaper, lending the local make of iron a little assistance. It, however, encourages the consumer of pig iron to press for still lower prices. It is understood that there are rather heavy stocks in the Northamptonshire district, but Derbyshire accumulations are not considerable. Buyers have little stock at their foundries, but they rely on the quick delivery which can generally be had. Orders are restricted to the smallest possible tonnages. There is no sign of any improvement at the forges in this district. In the present starved condition of the trade price stability is unattainable. Derbyshire forge can be bought under £3 8s. at furnaces and Northamptonshire at less than £3 4s.

Gas Consumption of Smethwick Industries.

There has been a remarkable increase in the use of gas for industrial purposes in the Smethwick area. In 1910 the gas consumed industrially was 84,000,000 cubic feet, to-day the figure is 366,000,000. This is equal to 38.5 per cent. of the total quantity sold by the Smethwick gas undertaking—94,807,300 cubic feet—against 19.62 per cent. in 1910. The yield of gas per ton of coal carbonised constitutes a record for the undertaking and justifies the policy adopted in reconstructing the vertical retort installation. Before the reorganisation the yield was 13,737 cubic feet, to-day the yield is 17,111 cubic feet per ton of coal carbonised.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THE iron and steel markets here opened after the holiday with a very feeble appearance. There may be a slight accumulation of orders, but one scarcely notices it if it be in existence, and the general feeling in iron and steel is weak and depressed. The theory of ironmasters and iron and steel manufacturers is, of course, that prices are now at the bottom and cannot be forced any lower; but if the present state of business is to last until the autumn one's experience leads one to expect that it will be quite impossible to keep prices from sagging. Of course, any downward movement must now be very slow, but in the absence of any adequate demand it will probably continue. Over and over again it has been pointed out that costs of production alone do not sustain markets. The only support of a market is demand, and when that fails anything may happen.

Metals.

The markets here for all the non-ferrous metals are very quiet and dull. There is no sign of improvement yet in the engineering demand, and there is not very much speculative demand. Most consumers seem to be content to go along in the old way, just buying what is needed for prompt consumption, and trusting to the dulness of trade to keep prices from rising against them. One cannot say that this has been a bad policy during the last year or two, although occasionally consumers have been caught by a sharp advance in tin. This seems to be about the only metal in which there is any risk of being caught short of supplies; and now that the price is up to about £250 per ton the risk is not great. Of course it is possible that tin may again reach £300, but, on the other hand, there is a possibility of a fall. As for copper it seems impossible for that metal to get out of the rut into which it has fallen. Movements of a pound or two either up or down may occur, but they are checked almost immediately. The actual demand for copper and its alloys in this district is very much below the average, and there is not much chance of an increase for the next few months. There have been further reports as to the gradual reduction of output in America, but they seem to have very little influence on feeling here or in London. What engineers require is not cheaper ingot copper, but a far less extravagant price for sheets and tubes. We want to get back to reasonable charges for manufacturing in the metal trade. Lead has been steady and rather firm, and although prices are not so extravagant as they once were, there is certainly plenty of room for a fall in this metal. But if one may judge from the forward market, there is at present no great expectation of cheaper lead. Spelter seems to be a fairly firm market now, and there has been a better demand of late for the galvanising trade.

Pig Iron.

There is very little going on here in the foundry iron market, although there was some little accumulation of orders to be placed at the beginning of the week. Founders, as a rule, are slack of work in this district, and many of them welcomed the Whit-week stoppage, and would perhaps like to prolong it. Some of the Derbyshire makers are still asking 82s. 6d. per ton for No. 3 delivered in Manchester, but a more usual price now is 81s. to 81s. 6d., and one hears occasionally of 80s. This last is considered by sellers to be a rock-bottom figure; but the consumers were told the same tale when the price came down to 85s. The fact is that there is still more pig iron suitable for sale on this market than is needed. The Northamptonshire makers quote 67s. 6d. per ton on trucks; but it is clear that if they want to keep on selling here they will have again to reduce the price, so as to bring their iron into Manchester at a less price than Derbyshire iron. It may come down to 65s. on trucks, then Derbyshire iron can scarcely be maintained at more than 70s. at the furnaces. Consumers here do not seem to be convinced that 80s. in Manchester is to be the bottom price, and consequently they are not yet buying in large quantities. Scotch iron is steady and quiet, but there is very little demand for it here. Possibly the cheaper East Coast hematite at about 10s. per ton less appeals to many of the founders who at one time always used Scotch

Finished Material.

Lancashire bar iron at the reduced price of £12 per ton does not find much favour here. The dispute as to the character of foreign bar iron still goes on, but consumers are not convinced that they must pay £12 to get genuine wrought iron. In the finished steel market general weakness prevails, of course, but British prices seem to be brought down to a point from which it is not easy to depress them further. For good easy specifications, both for sections and plates, no doubt concessions can be obtained, but the nominal prices are much the same as they have been for a long time. There is, of course, room for a lower price for boiler-plates, for it cannot be necessary to maintain the present difference between them and ship-plates.

Scrap.

The position here in the scrap iron and steel markets is very uncertain, and dealers do not know what is safe to do. The local market should not go any lower, but a large proportion of Lancashire steel scrap must be sold outside. Sheffield is now scarcely buying at all, and it seems probable that 60s. will have to be accepted for the next business that is done there. Hence steel scrap at a station in Lancashire is barely worth buying at 50s. per

ton, although it is said that some dealers pay 52s. 6d. There is a moderate demand from the forges for heavy wrought scrap at 75s. per ton delivered, as this is their cheapest ironmaking material. Founders here are buying only small lots of cast scrap and the market is weaker again As a rule, dealers will not sell under 75s. delivered for ordinary cast scrap, and for textile machinery scrap, of which there is not much, 80s. per ton is asked.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron trade is in a bad way, and there have been no developments during the week either one way or another. No more furnaces have been damped down since the previous week, but a further restriction is feared unless trade improves. The Millom and Barrow works, which have no furnaces in blast now, are supplying customers' needs from stock, and those needs are not heavy. The outlook seems very bad for there is no sign of better conditions obtaining. The business with Scotland has dwindled down very considerably, and that with the Midlands is on a very small scale speaking comparatively. The fact that the London, Midland and Scottish Railway Company has given notice to thirty local shunters and eleven guards gives some idea of the slump. Of course, it does not mean that these men will be off work entirely. They will be employed on a day-to-day basis and, of course, it means short time.

Iron Ore.

The iron ore trade has become much quieter, and most of the activity now in the North-West district is confined to the Cumberland pits. Very little local ore indeed is going out of the district, and as regards foreign ores the imports will be restricted in accordance with the reduced requirements.

Steel.

The steel trade is only in a poor way, but the order for rails by the London, Midland and Scottish affects the Workington rail mills, which have secured a portion amounting to ten thousand tons. This work will help to keep the furnaces going in that district. The mills have been closed down for a short period previous to which they were working off and on. There has been more activity in the sleeper mills than in the rail mills of late in Cumberland. The Barrow rail mills are idle and are likely to be so for a month or two. The hoop and small section mills at Barrow are better circumstanced and have orders to keep them going regularly.

Shipbuilding and Engineering.

On Tuesday Vickers launched from their Barrow yard the Orient Liner Otranto. This leaves only one vessel on the stocks, the cruiser Cumberland. The keels of the two Australian submarines will be laid very shortly. In the engineering departments there is more activity than on the shipbuilding side, where orders are very difficult to obtain. The Warren liner Newfoundland left last week on her trials, which have been carried out satisfactorily. The news that an order for the gun mountings for one of the Australian cruisers to be built by John Brown's on the Clyde has been placed with Vickers, is welcome.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Branches.

THERE is still no improvement to record in the condition of the heavy branches of local trade. Pig iron, steel billets, bar iron, scrap and rolled mild steel, are all under a cloud, which shows little sign of lifting. Prices of hard basic billets were reduced by 10s. per ton last week and it remains to be seen whether that will have the effect of stimulating buying. At present there is no forward ordering of supplies, and the specifications for immediate requirements are not sufficient to enable the furnaces to be worked on a remunerative basis. Not only are billet prices easier, but so also are those of hematite pig iron and Derbyshire foundry iron, as well as heavy basic scrap.

Big Orders for Steel Rails.

A cheering feature of the beginning of this week, which should have a good effect on the heavy trades, was the placing of large orders for steel rails by the London, Midland and Scottish Railway Company. No less than 26,000 tons of rails are to be made in this district—10,000 tons by Cammell, Laird and Co., Ltd.; 10,000 tons by Steel, Peech and Tozer; and 6000 tons by Samuel Fox and Co.; while the Workington Iron Company, which, like the two last-named firms, is a part of the United Steel Companies, is also to make 10,000 tons. The orders are very welcome and opportune. Owing to slackness of trade, there was danger that the companies would have had to suspend a considerable number of men, but it will now be possible to find employment for them for the next six months. The London, Midland and Scottish Railway Company has also placed large orders for steel rails in other parts of the country, namely, the East and West coasts, Staffordshire, Scotland and South Wales.

Australian Naval Orders.

Full particulars have now been published with regard to the Australian naval orders, which, as previously reported, have in the main come to firms associated with Sheffield. John Brown and Co., Ltd., will construct the two 10,000-ton cruisers at Clydebank. The cost of the hull and machinery of each ship will be over £1,000,000. The vessels will be similar to the five County class cruisers which are under construction for the British Government. Messrs. Vickers and Messrs. Armstrong, Whitworth and Co. will each supply the main armament for one ship. The contracts for the gun mountings have already been placed at approximately £350,000 with each firm, and further orders will shortly be given out for the remainder of the armament. The armour contracts, at a total cost for both ships of over £100,000, have been divided between Messrs. William Beardmore and Co., Cammell Laird and Co., and David Colville and Sons. Vickers, Limited, are to build the hull and machinery of two submarines, at a cost of about £300,000 for each vessel. The total amount of the various contracts is about £3,500,000. Inquiries from the local firms concerned in the orders show that they will not make much difference at present, as it will be some time before the work gets into full swing. The firms may, however, be able to retain some men whose services would otherwise have had to be dispensed with.

Engineering and Tool-making.

The trades which depend to any large extent on colliery requirements are quiet. Engineering generally is in a very unsatisfactory state, but there are on hand a few contracts of a special character which keep the shops going. The demand for machine tools has for some little time shown a falling tendency, and it is still in evidence. For engineering castings and forgings the demand is only moderate. The lighter and medium foundries have a number of orders, which, although of small dimensions, keep them running with a fair amount of regularity. A much more satisfactory state of things is to be found among the lighter manufactured trades. In the farm tool, saw and machine knife departments full work is the rule, and there are instances of overtime running. The demand for handsaws is especially good, and, although circular saws are not in quite such good request as they have been recently, it is believed that this condition is only temporary. Sweden is offering circular saw plates at prices much below those charged in Sheffield, and it is reported that a good many orders have been obtained for them. Some improvement is reported in the file trade, and sheep shears are selling better than last year, although the quantity being exported is still much below the normal. Trade with Russia shows little expansion, but a fair bulk of it exists, and is helping to keep several tool firms busy. Files and rasps, saws and saw blades, carpenters' and joiners' tools, and engineers' small tools, are the chief item of export. It is stated that credit is now being given to the Russian buyers, who, up to the present time, have fulfilled their obligations punctually.

Cutlery and Plate.

The depressed condition of these industries continues, and instances to the contrary are few. Reports from retailers show that purchases of table cutlery and plate by the public have fallen to an unprecedentedly low level. This is attributed, largely, to the fact that motoring and other recreations take people from home and lead to an extension of dining at hotels and restaurants. The growing practice of entertaining friends at public places instead of at home also produces a falling off in the domestic demand for cutlery and plate, and it is feared that a large proportion of this demand has permanently disappeared. The sale of silver services and cabinets of plate and cutlery has been in a declining condition for a considerable time. On the other hand, the requirements of public caterers show an expansion, and the Dominions continue to buy in substantial quantities.

Oil-fired Cooking Apparatus.

The adoption of oil-fired cooking apparatus on ships is on an increasing scale, and Moorwoods, Ltd., of Harlesden Works, Sheffield, are carrying out a number of contracts for such installations. The 7000-ton vessel Newfoundland, which Vickers Ltd. have just completed at Barrow for Messrs. Furness, Withy and Co., was equipped by Messrs. Moorwood with their complete system of oil-fired cooking apparatus, consisting of galley ranges for cooking for passengers and similar plant for crew, also bakery, boiling pans, hot presses, tea and coffee kettles, egg boilers, &c. The pantry equipment was also designed and supplied by the same firm. It consists of kneading machine, refrigerator, plate-washing machines, &c., with all the usual accessories. Messrs. Moorwood have on hand at present contracts for oil-fired cooking apparatus for the three new battleships Nelson, Rodney and Adventure. The whole of the apparatus is made at the Harlesden Works.

Conditions at Derby.

Two reports, of a condition the reverse of cheering, come from Derby. One is that the London, Midland and Scottish Railway carriage and wagon works are to be closed on Saturdays. This will affect 5000 men; the other is that a similar reduction of the working week is to be made at the Wolverton works, where another 5000 men are concerned.

New Sea Wall at Scarborough.

The task of saving the Royal Albert Drive at Scarborough has now been about half completed, and the Corporation has adopted a scheme for the remaining portion of the work. Two factors contributed to the danger of the drive—the erosion by the sea under the present wall and the pressure of a large mound of earth in Clarence Gardens, behind the road. The work of removing the mound has been in progress for a considerable time. Out of an estimated total of 100,000 tons of earth, 72,000 tons have been removed. The estimated cost of this removal was £25,000. The new scheme, which is to cost a further £26,000, provides for the taking down of the upper half of the sea wall at the most precarious position, and the construction of a wall sloping at an angle of 30 deg., and having a serrated face. The borough engineer reports that the work already done, in removing the large mound, has apparently slowed down the general seaward movement of the wall, which seems to have remained stationary for the last two months. He considers, however, that the angle of the top half of the cliff is still too great, and that it is desirable to reduce it as soon as practicable.

Colliery Developments.

The development at Brodsworth Colliery, near Doncaster, to which I referred a week or two ago, has been duly carried out, coal from the Parkgate seam having been brought to the surface. The seam is expected, when fully developed, to provide employment for 500 men. At Firbeck Colliery, where the Barnsley seam was reached in No. 2 shaft a month ago, the same coal has now been reached in No. 1 shaft. The depth is the same—826 yards—and the seam is 4ft. 6in. thick. Colliery enterprise in the Upton district, near Pontefract, has accentuated the problem of water supply to the extending housing areas of that part of South Yorkshire, and Pontefract Town Council has decided to make application to the Ministry of Health for permission to borrow £65,000 for the laying of an additional 16in. main from the works at Roall in duplication of the present service. It is also proposed, as soon as the necessary parliamentary sanction can be obtained, to proceed with the construction of an entirely new waterworks on a site which has been acquired a mile from the present pumping station.

NORTH OF ENGLAND.

(From our own Correspondent.)

More Pits Closing.

THE depression in the Northern coal industry has, if anything, deepened during the week, and, judging by present indications, the time is not far distant when the rate at which collieries are closing will be greatly accelerated. Efforts are being made at many of the collieries to adjust working arrangements with a view to making output cheaper, but they do not appear to be meeting with any success. The men employed at four of the Pelaw Main Collieries at Birtley have received fourteen days' notice to terminate their hiring, as the owners are unable in the present state of trade to carry on at the current high cost of production. There have been negotiations between the management and the men in the hope of carrying the pits on in these very difficult times, but they have proved ineffective, as the workmen have refused the terms offered to them. The percentages earned at these collieries range from 30 per cent. to 90 per cent. above the county average, which raises the rate of pay from 12s. 6d. to about 20s. per shift for the highest paid workers. In these circumstances the management asked for seven hours clear working time, which is in accordance with the Seven Hours Act, and no overlap of one and a-half hours as at present. If this overlap were avoided it is contended that each pieceworker would produce one ton more of coal than at present. The total effect of the new working conditions would be, it is said, to reduce the present export price of coal by about 1s. 6d. per ton and thus enable foreign trade to be obtained. Moreover, if the arrangement had been accepted by the men their percentage would still be 20 per cent. to 30 per cent. above the county average, each flat and district in the pits being considered on their merits. As a result of the decision 5000 men will be added to the army of 45,000 unemployed in Durham county. With a view to keeping its collieries going, the Consett Iron Company has asked the men to consider the question of a seven-hour shift, together with a reduction in piecework rates, but it is understood that there is a strong feeling against acceptance. The fourteen days' notice to terminate their employment served on 2200 miners at Shotton Colliery, Durham, expired on Saturday last, but arrangements have been made by which the colliery will continue working from day to day.

Cleveland Iron Trade.

It is difficult to find a single bright feature in the Cleveland pig iron trade. Prices continue to droop and, as usual on a falling market, consumers will only buy on a hand-to-mouth basis. Moreover, home industrial needs generally are very limited, so that consumption is restricted, and any hope of compensating advantages in an expanding export trade have been shattered by the fall in the franc, which has once more enabled the French manufacturers virtually to cut British producers out of the European markets, where British makers find it impossible to compete. It has, therefore, become a question whether work can be found for the plant now in operation. Certainly stocks are increasing, despite a restricted output, and if business does not improve more furnaces may be stopped. At the moment there are thirty-eight blast-furnaces in operation on the North-East Coast, the projected stoppage of the Tees Bridge Ironworks at Stockton having been postponed for a short time. No. 3 G.M.B. Cleveland pig iron is now no more than 74s. per ton, with No. 1 offered at 78s. 6d., No. 4 foundry at 73s., and No. 4 forge at 72s.

Hematite Pig Iron.

Export business has almost ceased in the East Coast hematite pig iron trade, and even home sales are negligible. Prices consequently continue to decline, and mixed numbers are now on offer at 79s. 6d. per ton, with the possibility of business at 79s., whilst No. 1 stands at a premium of 6d. per ton.

Ironmaking Materials.

The foreign ore trade is in a lifeless state, and 22s. per ton c.i.f. Tees is purely a nominal sellers' price of best Rubio ore. Sellers of good Durham medium furnace coke still ask 22s. per ton delivered at the works, but probably 21s. 6d. would not be refused, as there is very little demand.

Manufactured Iron and Steel.

There is little improvement in the demand for manufactured iron and steel trade, and the only firms really busy are the makers of galvanised sheets, which command £16 10s. per ton for 24-gauge. Foreign bars being cheaper, black sheets have been reduced to £11 5s. per ton. An all-round drop of 10s. has been made in steel billets, the new quotations being:—Hard billets, £9; medium, £8; and soft, £7 10s. For steel plates makers ask £8 15s. to £8 17s. 6d. Other prices are unchanged.

The Coal Trade.

The position in the Northern coal trade is very discouraging. With so many pits in Northumberland and Durham closed and the prospect of more ceasing to operate, one might have thought that ere now the supply would have approximated the demand, but that is not the case, as fuel of every description is offered abundantly. Merchants who have returned from abroad state that there is no indication of any improvement in the position, for there are huge stocks of coal all over Northern Europe, a fact which puts merchants at a great disadvantage in their efforts to secure business from foreign customers. Prospects of revival in demand are remote. Under these circumstances transactions are on a limited scale and inquiries circulating for this month and onwards are very meagre. Fitters endeavour to hold to steady prices, but the position is against them, and to secure what little business is available they have to give way, and in very few grades is there any steadiness in tone. Best steams for prompt are worth 16s. 9d. to 17s. per ton, but for all June shipment 16s. 6d. to 16s. 9d. per ton is the best obtainable. There is no pressure for gas coals, and prices are on the downward trend. The demand for bunker coals for ships' use and export to the coaling stations is dull. Supplies are in ample quantity at prices ranging from 15s. 6d. to 16s. 6d. per ton, according to brand. The coke trade remains very quiet. Gas coke is pressed for sale and transactions are effected at low values, ranging from 16s. 6d. to 17s. per ton.

SCOTLAND.

(From our own Correspondent.)

Deepening Depression.

THE depression in the steel, iron and coal trades becomes still more acute. Almost every day that passes brings evidence of it in the form of announcements of concerns closing down until better times. For some time back collieries have been closing down or reducing operations, and now similar reports concerning engineering and other establishments are coming to hand. Where work is maintained it is almost certain that the holiday season will be either commenced before the usual date or prolonged beyond the ordinary limits.

Manganese in the North of Scotland.

In the interests of a North of England steel concern prospecting has been recently carried on in the Banffshire district in connection with manganese ore deposits which are known to exist in considerable quantities between Donside and Avonside in the Hills of Lecht. A vein of red oxide (red hematite) occurs in these hills extending to about two miles in length, and should prospects be encouraging the extract of the mineral may be developed on a considerable scale. As far back as 1739 this vein was worked for iron ore by the York Building Company. In 1841 a pit was sunk 85ft. deep to ascertain whether it would be worth while extracting the manganese ore with which the iron ore was mixed. It was found in sufficient quantity and quality and was conveyed to Newcastle to be prepared for use in bleaching, fetching £8 per ton. On the discovery of the utility of chlorinated lime as a bleaching agent the industry was abandoned on economic grounds, the price obtained for the ore having fallen to £3 per ton.

Steel and Iron.

Practically nothing of fresh interest has been made public during the past week in connection with the steel and iron trades and business in most departments is slow in the extreme. There is little chance of steel plates and sections improving their position for some time to come in view of the slackness at the shipyards and engineering shops on the Clyde. Steel sheets show a fair turnover, somewhat under the average for black, but a good business in galvanised varieties. Some fair orders for steel rails have been mentioned. Prices for plates, sections and black sheets are mostly a matter of arrangement and cheap quotations are hinted at in view of continued continental competition. Bar iron works remain short of new tonnage and the turnover diminishes both for home and export. Re-rolled steel also is most disappointing. Pig iron is stagnant and quotations show further weakness. Scrap material shares in the general slackness.

Coal.

There is absolutely no sign of improvement in the Scottish coal trade, and the closing of pits must inevitably be accelerated under present conditions. Demands are shrinking as quickly as outputs, and at many collieries the sidings are filled with wagons of unsold fuel. Exporters find the difficulties of doing business almost insurmountable owing to the large stocks held abroad and German competition, while the position has been further complicated by the strike in Denmark. Labour troubles are threatening in certain areas at home, and altogether the situation is intensely problematical. Practically all descriptions of fuel are weak, the only exception meantime being first-class Fifeshire steams. The home market is no better off than the export department. Aggregate shipments for the week amounted to 192,730 tons, against 198,734 tons in the preceding week and 260,179 tons in the same week last year.

Meeting of Mine Owners.

The Lanarkshire, Fife and Clackmannan, East and Mid-Lothians, and the Ayrshire Associations of Scottish coal masters are to hold separate meetings in the Central Station Hotel, Glasgow, on Monday, June 15th, to consider the report of the sub-committee which, along with representatives of the miners, has been investigating the position of the mining industry and the means of alleviating the depression. A joint meeting will follow, when the question of combined action will be discussed.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE conditions in the steam coal trade have been very depressing during the past week. They could have scarcely been quieter had holidays prevailed, as the quantity of business being done has been negligible. The foreign inquiry has not improved and orders come along very slowly, while prices continue to be very unsatisfactory. No doubt the state of the foreign exchanges is a contributory factor in holding up business, and a natural consequence is that values of coals for prompt orders are extremely uneven and a matter of individual negotiation. Most collieries are in need of business for immediate delivery, as may be gauged from the fact that the week commenced with 17 loading appliances idle at the various docks. Chartering has been a little more active than was the case last week, but still the amount of tonnage taken up is well below the average and quite unequal to what is required to serve the needs of the collieries.

Miners' Wages Agreement.

During the past week-end the report was current that an early settlement of the question of a new wages agreement could be looked for, and it was stated that it involved a 46-hour week in place of the present 42-hour week, and further that the 14.2 per cent. increase in lieu of decreased production by reason of the reduction in the working hours from eight to seven per day would be discontinued. It is difficult to trace the source of this report, but it is sufficient to state that there is no foundation for it, inasmuch as the coalowners and the miners' leaders have not as yet arrived at the negotiating stage. Neither side has so far submitted proposals for a new agreement, and it may be a few weeks before they do so. There is, of course, a good deal of speculation as to what is going to happen regarding the existing agreement. It is practically certain that the miners will not give notice on July 1st to terminate the agreement, and a statement in the current issue of the official organ of the South Wales Miners' Federation supports that view. The question therefore is, what step will the coalowners adopt ? The general belief is held that the coalowners will give the requisite notice on July 1st to end the agreement, though they may be prepared to operate the existing agreement provided they can secure a return to an eight-hour working day, which means, of course, that the Seven Hours' Act would have to be amended. Miners' leaders are emphatic, however, that the Federation will not on any account agree to an increase in working hours, and if that attitude be persisted in, it would not be surprising if the coalowners, having given notice to terminate the present agreement, then set forth the terms which they are prepared to accept, and those will form the basis of negotiation, so that it may be easily the end of July before anything really is known about what is going to happen in the coalfields.

Coalfield Items.

The Coedely collieries of the Welsh Navigation Company restarted on Thursday last week on a single shift basis, with the result that about 600 workmen were given employment. Although it was understood last week that the Mardy Collieries belonging to the Lockets Merthyr Company were to be closed down, the position turns out not to be so bad, as the No. 2 pit is being worked, which means employment for about 800 to 900 miners.

Tin-plate News.

The annual meeting of the Industrial Council of the Welsh Tin-plate Industry passed off satisfactorily at the end of last week. Considerable interest was manifested in the proceedings, on account of the fact that the workmen's representatives had displayed a desire to take a hand in the control of the industry, to judge by the subjects they had put down for discussion, such as the policy of the trade towards stabilisation and the necessity for the re-establishment of the stabilisation committee ; the relationship of the workmen's representatives to such committee and its policy and the return of the gold standard and its effect upon trade, &c. The employers expressed their willingness to have an inquiry as to what could be done to meet requirements with regard to ventilation and sanitation in certain of the works, which was acceptable to the workmen's leaders, and the chairman of the employers replied to the statements of the men's representatives on the other questions raised. Questions of wages are not dealt with at the annual meeting, but the employers came to an arrangement whereby action can be expedited for dealing with grievances that may exist, and this was approved by the workmen's leaders.

Steam Coal Colliery Deal.

The agreement come to for the acquisition of the Windsor Colliery by the Powell Duffryn Steam Coal Company was confirmed at a special meeting of the shareholders of the Windsor Company at the end of last week, when the directors were authorised to carry it into effect. It was officially stated that the purchase price was £250,000, which would be sufficient to clear the Windsor Company's debenture issue and creditors, and leave some balance for distribution amongst the 10 per cent. first preference shareholders, but it was quite certain that the holders of the 6 per cent. preference shares and the ordinary shareholders would get nothing.

Current Business.

Actual business has been little or no better than it was last week when the holidays were taken. Practically no fresh business has come along, and the general tone of the market is quiet and on the easy side for prompt loading. Quotations have not changed to any material extent, though any buyer able to take quick delivery can almost invariably secure his requirements on more favourable terms than are indicated. Supplies of standing coals are fairly heavy, and the difficulty of the collieries is to get the quick clearance of their wagons to enable them to maintain work at the pits. Both large and small coals are very irregular, and there is no alteration in patent fuel and coke.

The Institution of Civil Engineers.

APRIL EXAMINATIONS, 1925.

PASS LIST (*INTERIM*).

(Subject to confirmation by the Council.)

The results of the Examination held abroad will be announced later.

Preliminary (57).—R. F. Allen, H. S. Andrew, J. Baker, J. L. Beckett, P. R. Bedford, A. Begleman, C. H. Brown, A. Burrows, C. G. Casswell, H. W. Clark, R. D. Clark, V. H. Coleman, R. M. Crichton, J. F. Darnborough, E. R. Davies, P. M. Dick, G. Downing, H. Duckworth, W. G. Dunstan, H. V. Evans, H. M. Everett, J. W. S. Fawcett, J. E. Fforde, T. Forrest, S. J. Gale, F. J. Grevatt, H. L. Hammond, A. R. Hanson, H. Haughton, J. G. H. Heasman, E. L. Hogg, H. T. Hough, R. A. Hutson, A. Inglis, R. Johnson, D. D. Kaila, D. P. Kinsey-Miles, H. G. Knight, J. H. Lovett, R. A. Lyall, F. S. Neale, J. W. Pallister, J. Platt, A. G. Richardson, J. Russell, J. Semple, J. G. Shakespeare, E. R. Sly, F. Smith, H. V. Smith, W. J. Smith, C. K. Stuart, J. C. Thomson, C. E. Watson, H. N. Wilford, T. U. Wilson, N. L. Wyatt.

ASSOCIATE MEMBERSHIP (256).

Whole Examination (Sections A, B and C) (8).—A. Boothman, L. T. Bridgwater, A. G. Bugden, A. J. H. Clayton, G. A. Parfitt, E. O. Rose, F. W. Sully, C. R. Wallace.

Sections A and B only (22).—J. F. A. Baker, H. C. Barrett, E. F. Blackbourn, J. L. Bliss, A. F. Chapman, F. Dickinson, N. R. Elliott, T. H. Elstob, L. B. Escritt, S. Feather, F. I. S. Gill, G. L. Gundry, W. Hamilton, J. B. F. Hawkins, G. Hebson, C. E. M. Herft, E. W. E. Lane, P. R. Settle, A. B. Sharp, jun., A. Tims, R. V. Trace, R. H. C. Woodham.

Sections A and C only (2).—J. A. McManus, G. W. Nash.

Sections B and C only (18).—E. L. Allman, O. W. Berry, D. G. Blyth, F. Brown, A. Cheyne, J. W. D. Cook, J. H. Ellacott, A. Hargreaves, E. T. T. Hussell, J. B. Innes, W. C. Le Bas, F. Lee, H. L. Lloyd, A. R. Smee, W. Sowerby, H. O. Vaux, R. A. Williams, D. Yorke.

Section A only (50).—H. A. Anderson, jun., R. H. Austin, J. H. Barton, J. Blackburn, R. G. Booth, W. S. Catlow, W. A. Clarkson, A. G. Copsey, P. G. Corder, T. Donkin, R. M. Drynan, F. Eaves, H. Eaves, W. S. Evans, W. E. Fecher, A. W. B. Gill, R. A. Harrison, G. F. Henderson, G. Holbourn, J. H. Humphreys, D. J. H. Kelly, H. J. F. Kempthorne, G. F. Kent, W. A. Knighton, C. C. Knowles, N. Lamond, J. E. Lewis, W. B. Macfarlane, J. MacNiven, J. Matthews, J. Oldfield, A. C. Page, F. L. Pasley, R. Pearce, J. Penman, G. A. Phillips, J. R. Porteous, T. Porter, E. J. C. Reed, W. D. G. Rees, L. Reeves, W. A. R. Robertson, N. L. Samson, D. D. Thorp, W. S. Visick, F. W. Waddell, B. Whitteron, D. R. Williamson, A. C. Wilson, L. McI. Winchester.

Section B only (40).—M. E. Adams, C. G. Alderton, L. Bown, D. V. Buck, H. F. Bull, W. Butterworth, L. Cookson, H. L. Copestake, P. W. Davey, J. A. McK. Donnelly, R. H. Edwards, T. E. Everest, W. J. C. Garrard, F. W. Goodman, D. E. Holden, L. M. Howard, N. L. Jaggar, F. R. Keene, E. L. Keeting, F. Kendall, C. R. Kinton, F. X. Koenig, E. B. J. Lanyon, H. F. Lea, F. C. L. Lloyd, J. Long, A. K. MacKereth, N. H. Menesse, C. C. Parkman, C. R. Porter, E. J. Powell, J. Sewell, H. C. Sharpe, T. F. B. Simpson, H. L. Smith, A. Spence, J. O. Taudevin, A. Tillotson, C. F. Walker, A. C. Webber.

Section C only (116).—G. L. Ackers, J. L. Adamson, D. L. Anderson, C. E. Andreae, B.Sc. (Glas.), R. Arbuthnott, G. M. Ashwell, W. T. Bamford, B.Sc. (Eng.), J. Bedford, B.Sc. (Eng.), R. C. Beecroft, M. Eng. (Sheffield), B. A. Bent, H. J. Berry, P. G. Bhagat, B.Sc. (Glas.), A. M. Binnie, B.A. (Cantab.), T. E. Bourdillon, B.A. (Cantab.), T. Breslin, J. L. Broom, W. A. Broom, H. C. Brown, B.Sc. Eng. (Lond.), W. M. W. Brunyate, M.C., B.A. (Cantab.), W. C. Budd, F. H. R. Cane, D. H. Cameron, B.Sc. (Edin.), J. T. Chalk, B.Sc. Eng. (Lond.), A. A. Clements, B.Sc. Eng. (Lond.), L. H. Clemetson, B.Sc. Eng. (Lond.), E. G. Cove, B.Sc. (Bristol), D. D. Crabbe, B.Sc. (Edin.), A. Crawford, B.Sc. (Durham), S. R. Crowhurst, B.Sc. Eng. (Lond.), G. L. Davies, B.Sc. Eng. (Lond.), S. J. Davies, G. A. Dawson, B.Sc. (Glas.), I. A. J. Duff, B.A. (Cantab.), H. Eastman, A. A. El-Seifi, S. L. Engel, K. J. H. Evans, B.Sc. Eng. (Lond.), W. J. Evans, J. L. F. Fenwick, D. C. Field, B.A. (Cantab.), F. J. Forty, B.Sc. (Glas.), F. M. Fuller, S. K. Ghosh, B.Sc. (Edin.), F. Gibbons, B.A., B.A.I. (Dublin), A. J. Gould, B.Sc. Eng. (Lond.), E. Granter, R. F. B. Grundy, B.Sc. Eng. (Lond.), B. Hackforth, B.Sc. Eng. (Lond.), L. W. H. Hall, B.Sc. Eng. (Lond.), J. E. C. Hill, B.Sc. (Edin.), J. A. G. Howard, J. K. Hunter, B.Sc. Eng. (Lond.), J. G. Jefferson, W. H. Kelly, R. C. Kelt, B.Sc. (St. Andrews), A. E. Kent, B.Sc. Eng. (Lond.), C. M. Kerr, R. A. Kidd, B.Sc. (St. Andrews), J. G. Kimber, L. W. Lillingston, B.Sc. Eng. (Lond.), J. McL. Lister, T. A. MacLachlan, A. Macnaughton, B.Sc. (Edin.), H. A. Magnée, B.Sc. Eng. (Lond.), W. Manning, T. G. Marple, C. M. Marsh, B.Sc. Eng. (Lond.), F. C. Martin, R. T. Martin, M.C., C. Mellor, W. G. Miles, H. F. Molony, B.A., B.A.I. (Dublin), W. G. Morrison, B.Sc. (Edin.), R. W. Mountain, B.Sc. Eng. (Lond.), C. W. J. Mountford, B.Sc. Eng. (Lond.), J. G. Murray, M. Nachshen, B.Sc. Eng. (Lond.), H. F. Naish, A. B. Newby, R. J. Nichols, J. North, B.A. (Cantab.), J. A. Parkinson, jun., H. S. Parratt, B.Sc. (Leeds), W. Parvin, L. Patrick, B.A. (Cantab.), A. H. Pavitt, T. F. Peachey, C. Peel, B.Sc. Eng. (Lond.), C. A. Phillips, G. A. Pitt, B.Sc. Eng. (Lond.), J. L. Raitt, B.Sc. (Glas.), J. Rawlinson, B.Eng. (Liverpool), H. C. Reeves, B.Sc. Eng. (Lond.), E. F. Reid, B.A. (Cantab.), D. H. B. Reynolds, B.A. (Cantab.), K. Rowell, B.Sc. Eng. (Lond.), T. R. B. Sanders, B.A. (Cantab.), H. Savage, B.Sc. Eng. (Lond.), P. E. Sleight, M.Eng. (Sheffield), H. C. Smith, L. G. Smith, R. H. T. Smith, F. S. Snow, H. R. G. K. Stone, F. J. Symonds, D. L. Thornton, B.A. (Cantab.), K. B. Turner, B.A. (Cantab.), G. E. Turpin, E. H. Vick, A. C. Vivian, B.Sc. Eng. (Lond.), W. J. Watson, J. H. Willans, A. Williams, D. G. Williams, B.A. (Cantab.), R. Williams, B.Sc. (Durham), F. G. Woollard, B.Sc. Eng. (Lond.).

CONTRACTS.

JOHN DAVIS AND SON (DERBY), Ltd., of Derby, have received an order from the Firbeck Main Collieries, Ltd., for that firm's first installation of "Derby" miners' electric lamps and lamp-room equipment.

DANIEL ADAMSON AND CO., Ltd., of Dukinfield, Manchester, have recently received orders for machinery of various kinds for use in sewage disposal from Bamford, Derbyshire; Billington, near Macclesfield; Chapel-en-le-Frith; and Greasborough.

WE are informed by the International Combustion, Ltd., of Africa House, Kingsway, that its associated company, Combustion Engineering, Ltd., has secured a contract from the St. Maurice Lumber Company, through Messrs. McLellan and Junkersfeldt, consulting engineers, for a "Lopulco" pulverised fuel equipment for four Babcock and Wilcox boilers, each having 10,470 square feet of heating surface with a working pressure of 130 lb. per square inch.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	20/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 7 6	—
No. 1 Foundry	4 7 6	—
No. 3 Foundry	4 5 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 19 0	3 19 0
No. 1	3 19 6	3 19 6
Cleveland—		
No. 1	3 19 0	3 19 0
Silicious Iron	3 19 0	3 19 0
No. 3 G.M.B.	3 14 0	3 14 0
No. 4 Foundry	3 13 0	3 13 0
No. 4 Forge	3 12 0	3 12 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 7 6 to 3 9 0	
,, Forge	3 4 0 to 3 6 0	
(3) Derbyshire—		
No. 3 Foundry	3 12 6	—
Forge	3 8 0	—
(3) Lincolnshire—		
No. 3 Foundry	4 0 0	—
No. 4 Forge	3 15 0	—
Basic	3 15 0	—
(4) N.W. COAST— N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 12 0 (a) / 4 14 0 (b) / 5 0 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 12 6	—
Best ,,	—	—
N.E. COAST—		
Common Bars	11 12 6	—
LANCS.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 10 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 7 6	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 7 6	—
Gas Tube Strip	13 0 0	—

STEEL.

	(6) Home. £ s. d	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 10 0	—
Ship Plates, ½in. and up	8 12 6	—
Sections	8 2 6	—
Steel Sheets, under 3/16in. to ½in.	10 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 10 0	—
Angles	8 5 0	—
Boiler Plates	12 10 0	—
Joists	8 5 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 15 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 0 0	—
Soft Billets	7 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 15 0†	—
Light ,,	9 0 0 to 9 5 0	
Billets	8 0 0 to 11 0 0†	
MANCHESTER—		
Bars (Round)	9 0 0 to 10 0 0	
,, (others)	8 15 0 to 9 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 5 0	—
,, (Lancs. Boiler)	12 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 0 0 to 9 5 0	
Intermediate Basic	8 0 0 to 8 15 0	
Soft Basic	7 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
MIDLANDS—		
Small Rolled Bars	8 15 0	—
Billets and Sheet-bars	6 17 6 to 7 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	8 7 6 to 8 15 0	
Joists	8 7 6 to 8 15 0	
Tees	9 7 6 to 9 15 0	
Bridge and Tank Plates	9 0 0 to 9 5 0	
Boiler Plates	13 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/- to 20/3
Block Tin (cash)	253 7 6
,, (three months)	254 10 0
Copper (cash)	£5 5 0
,, (three months)	60 5 0
Spanish Lead (cash)	33 16 3
,, (three months)	31 8 9
Spelter (cash)	33 18 9
,, (three months)	33 11 3
MANCHESTER—	
Copper, Best Selected Ingots	62 10 0
,, Electrolytic	63 10 0
,, Strong Sheets	88 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis price)	0 0 11½
,, Condenser	0 1 2
Lead, English	35 15 0
,, Foreign	34 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8 to 1/9 per lb.	
Ferro Tungsten	1/5 to 1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 5 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	15/6
,, ,, 1 p.c. ,,	£52 0 0	17/-
,, ,, 0.70 p.c. carbon	£57 10 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 15 0	scale 5/- per unit
,, ,, 75 p.c.	£22 10 0	scale 6/- per unit
,, Vanadium	17/- per lb	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/- per lb	
Nickel (per ton)	£175	
Cobalt	10/3 per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/9
,, ,, Ell	14/9
,, ,, Splint	15/9 to 18/-
,, ,, Trebles	14/6
,, ,, Doubles	13/6
,, ,, Singles	12/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/9
,, ,, Splints	15/9
,, ,, Trebles	14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/6 to 15/6
Screened Navigation	21/6
Trebles	14/6
Doubles	12/6
Singles	12/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/9
Secondary Steam	14/3
Trebles	14/9
Doubles	13/3
Singles	12/6

ENGLAND.

(2) N.W. COAST—	
Steams	26/-
Household	45/- to 58/4
Coke	28/-
NORTHUMBERLAND—	
Best Steams	16/6 to 17/-
Second Steams	16/3 to 16/6
Steam Smalls	10/6 to 11/9
Unscreened	15/6 to 16/6
Household	23/6 to 25/-
DURHAM—	
Best Gas	18/9 to 19/-
Second	16/6 to 17/-
Household	23/6 to 25/-
Foundry Coke	20/- to 22/6

SHEFFIELD—	Inland.	
Best Hand-picked Branch	30/- to 33/-	—
Barnsley Best Silkstone	26/- to 27/-	—
Derbyshire Best Brights	26/- to 28/6	—
,, ,, House	23/6 to 25/6	—
,, ,, Large Nuts	18/- to 22/-	—
,, ,, Small	14/- to 16/-	—
Yorkshire Hards	18/- to 22/-	—
Derbyshire ,,	18/6 to 22/-	—
Rough Slacks	10/- to 12/6	—
Nutty ,,	8/6 to 10/-	—
Smalls	3/- to 5/6	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	21/3 to 22/3

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	26/- to 26/3
Second ,, ,,	25/- to 25/9
Best Dry Large	24/6 to 25/-
Ordinary Dry Large	23/6 to 24/6
Best Black Vein Large	24/3 to 24/9
Western Valley ,,	23/6 to 24/6
Best Eastern Valley Large	23/- to 24/-
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	15/- to 15/9
Ordinary ,,	13/- to 15/-
Washed Nuts	20/- to 27/6
No. 3 Rhondda Large	26/6 to 27/-
,, ,, Smalls	16/6 to 17/-
No. 2 ,, Large	21/- to 22/-
,, ,, Through	18/- to 20/-
,, ,, Smalls	11/- to 12/-
Foundry Coke (export)	40/- to 45/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	22/- to 26/-
Pitwood (ex ship)	23/9 to 24/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	41/6 to 43/-
Seconds	36/- to 39/-
Red Vein	28/6 to 31/6
Machine-made Cobbles	52/6 to 55/-
Nuts	50/- to 54/-
Beans	35/- to 37/6
Peas	21/- to 23/-
Breaker Duff	8/- to 8/3
Rubbly Culm	12/9 to 13/-
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 21/-
Smalls	10/- to 13/-
Cargo Through	16/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/6, with fluctuations according to analysis; open market, 18/- to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Situation.

THE slowing down of work at the mills and iron-works is the more significant because it has become general, not only in the northern departments of France but also in the Saar, where ironmasters have until recently been able to carry on active dealings with South Germany. Very low prices are being quoted to German consumers, but few orders are forthcoming. The heavy fall in the value of the franc has failed to stimulate a foreign demand, and producers no longer regard a depreciated currency as favourable to export business, for when the requirements abroad have shrunk to a point at which there is no excuse for speculative buying, the monetary depreciation can only be regarded as a source of worry. It necessarily means a contraction of purchasing power on the home market. The French look upon their bank notes as of doubtful value, and there is consequently no stability in the values of commodities. A crisis is inevitable unless the State succeeds in putting its finances in order.

The Coal Trade.

An official intervention between coalowners and colliers to induce the former to concede a claim for higher wages on the ground of increased living costs, has been met by an offer to grant one half of the advance which the miners are insisting upon as an irreducible minimum. The coalowners declare that they are unable to go beyond this concession. Their situation has for a long while past become steadily worse, for while the production has increased the costs have been growing out of all proportion on account of the higher wages and lower individual output. Selling prices have been kept down by the competition of British coal, and the margin between the two is now so small that any profit would be wiped out by any appreciable advance in miners' wages. The men are now considering the offer of the coalowners to meet them half way, and if they refuse to accept the terms a strike appears to be inevitable.

Import Duties.

For more than a year past a new Tariff Bill has been prepared after consultation with representatives of industrial interests, and the character of the Bill may be judged from the raising of the existing coefficients until such time as the new measure could be introduced into the Chamber of Deputies. The industrial representatives have been carrying on persistent propaganda in favour of a more stringent policy of protection, and they appear in most cases to have overcome the opposition of the commercial classes, who insist that the prosperity of the country depends upon a lowering of the barriers that may interfere with an interchange of goods. It was announced some time ago that the Tariff Bill would be introduced during the coming month, but it appears as if it will be still further delayed for the reason that the present situation renders it almost impossible to settle upon a definite fiscal policy. So far as the protection of manufacturing industries is concerned, it is difficult to see how much more can be expected than is being accomplished by the falling franc. No country with sound currency can compete with French manufacturers in their own market, where prime costs do not advance at anything like the same rate as the monetary depreciation. The time will come when a financial stabiliy will turn the tables against French makers, but for the moment the passing of a new Tariff Bill would prepare the way for further difficulties in the future. Again, the question of tariffs is rendered very delicate by the necessity of arranging commercial treaties with other countries. Experience of the past few years has shown the French that any attempt at raising barriers against foreign goods has the effect of provoking retaliation from other countries which have nothing to lose from endeavouring to shut out French products. The McKenna duties have done more than anything else to convince people in this country that a sound fiscal policy can only be pursued on a fair give and take basis, and that if foreign buyers are to purchase French goods there must be some equivalent in French purchases abroad. The policy now adopted of expanding exports and cutting down inports as much as possible cannot be followed indefinitely. During the past week the subject has come up for serious discussion, when it was affirmed that the French policy should be neither in the direction of Protection or of Free Trade, but of a normal interchange of goods. This is the first time that an authoritative pronouncement of the kind has been made. It implies that a considerable change has taken place in the official attitude towards the commercial policy of the future, and it means that a serious effort will be made to adopt reciprocity in the system of commercial arrangements which it is hoped to effect with other countries. This change was inevitable in a country which is depending more and more upon an export trade.

Mont Blanc Cableway.

A cableway for passenger traffic is now under construction from near Chamonix to the Aiguille du Midi, an altitude of 3843 m.—12,600ft.—and it is hoped to continue it eventually to the top of Mont Blanc. It consists of four cables, one on which run the trolleys of the cars, a traction cable for hauling the car, a brake cable which comes into operation and permits of the vehicle continuing its journey in the event of a breakage of the trolley cable and a cable for keeping the car steady. There are two lines, for up and down traffic, carried on steel girder standards varying in height from 12 m. to 33 m., each standard being built on a massive concrete foundation. Each car will carry eighteen passengers at an average speed of 2.50 m. per second, or just over 5½ miles per hour. The power will be supplied by a 100 horse-power electric motor. The line has already been completed beyond the first station at La Para, an altitude of 1790 m., and it is expected that the La Glacière Station will be completed next winter. From that point the line offers increasing difficulties and, when finished, it will be the highest cableway of its kind in the world.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

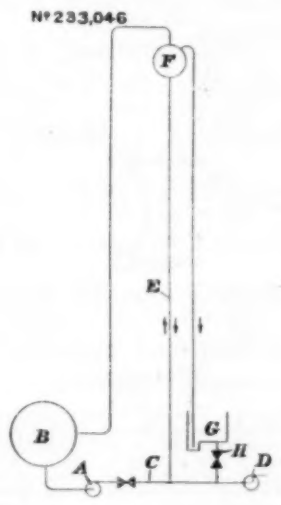
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

233,046. February 1st, 1924.—FEED WATER SYSTEMS, A. Stubbs, Ferndale, Swanlow, Winsford, Cheshire; and the Metropolitan-Vickers Electrical Company, 4, Central-buildings, Westminster.

This arrangement is intended to accommodate abnormal divergencies between the discharge from the condensate pump of a condenser and the demands of the boiler feed pump. The condensate pump A sucks water from the condenser B and passes it on by the pipe C to the feed pump D. A branch E off this pipe leads to a surge tank F, which is connected with the

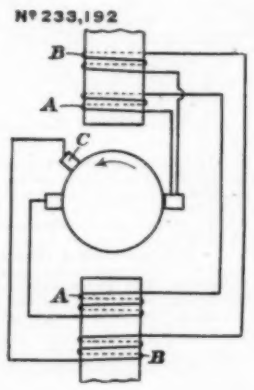


vacuum space of the condenser and also with a second open surge tank G. This tank communicates with the feed pump suction through the non-return valve H. If the condensate pump delivers more water than is required by the feed pump the water accumulates in the surge tank F until it overflows into the tank G. If the feed pump takes more water than is coming from the condensate pump F that tank is emptied and the non-return valve H opens so that a further supply of water is available. The tank F is, of course, arranged above barometric height.—*May 1st*, 1925.

DYNAMOS AND MOTORS.

233,192. July 1st, 1924.—DIRECT-CURRENT DYNAMOS, A. C. Lock, 22, Chelsham-road, Clapham, London, S.W. 4; and V. J. S. Russell, Nicoya, Woolstone-road, Catford, London, S.E. 6.

This dynamo is of the type commonly used on motor cars for charging accumulators, in which a third brush is used for supplying current to a regulating field winding. In it the shunt winding and additive winding are so proportioned relatively to one another that the shunt winding provides not more than one-

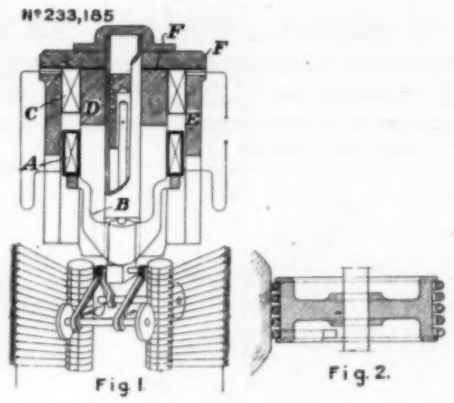


half of the total field when the machine is running under such conditions that the armature distortion begins to be effective, that is to say, at or slightly below the speed at which the dynamo will normally be driven. The normal shunt field winding is shown at A A, while the regulating winding is marked B B and is fed from the brush C. The two windings are so proportioned that the sum of their characteristic curves produces a flat characteristic. Particulars of a typical winding are given.—*May 7th*, 1925.

ELECTRICAL APPLIANCES.

233,185. June 24th, 1924.—REGULATING APPARATUS, Société Alsacienne de Constructions Mecaniques, Mulhouse, Haut-Rhin, France; and L. Wasser, Bavilliers, Belfort, France.

This invention is concerned with rheostats automatically controlled through a solenoid and aims at reducing contact friction and maintaining a constant controlling force. The first requirement is met, as shown in Fig. 2, by making contact with a roller, round the rim of which there is wound a loose helix of wire. This wire is free to follow inequalities in the contacts effectively without any great pressure or friction. The actuating solenoid is shown in Fig. 1 and comprises a moving coil A

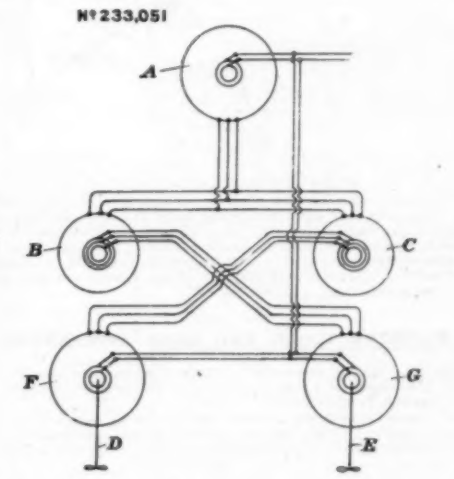


attached to the armature B, which moves in the annular field produced by the fixed coil C between the central pole D and the annular pole E. The inventors say that if the ampère turns of the two coils are similar the desired result is obtained, but that it is preferable to have air gaps at F F between the core and the yoke of the magnet.—*May 7th*, 1925.

TRANSMISSION OF POWER.

233,051. February 2nd, 1924.—ELECTRIC SHIP PROPULSION, The British Thomson-Houston Company, Crown House, Aldwych, London, W.C. 2; and D. E. Jewitt, Sunnybank, Old Bilton, Rugby.

The object of this invention is to provide a system of propulsion for a twin-screw ship wherein a single generator supplies power to both propellers, whilst each propeller speed automatically accommodates itself to give an equal division of power between the two propellers under all service conditions. The inventors employ a polyphase alternator which supplies power to two induction motors coupled one to each of the propeller shafts, each induction motor being connected in cascade with a direct-current excited synchronous motor coupled to the propeller shaft associated with the other induction motor. With this arrangement any variation from the equal division of power between the two propellers automatically varies the relative speeds in a manner to restore the equilibrium. This system may be employed as an auxiliary cruising equipment, in which case the auxiliary power may be added to the main propelling power when the vessel is being propelled at its maximum speed by cutting out the synchronous motors and utilising the induction motors only. In the illustration A is the alternator, B and C are the three-phase induction motors, which are coupled with the



propeller shafts D and E, while F and G are the synchronous motors. In operation, assuming that the speeds of the propeller shafts are initially equal, and that, subsequently, the thrust on the shaft D increases whilst that on the shaft E decreases, the induction motor B will run at a lower speed than the motor C and thus cause the rotor frequency of motor B to rise and increase the speed of the synchronous motor G. The speed of the motor C will rise on account of the combined effect of the reduced propeller thrust on the shaft E and the speeding up of motor G, and that will lower the rotor frequency of motor C and in consequence motor F will also fall in speed. The speeds of the shafts D and E thus automatically adjust themselves until the thrusts are equalised. When starting up from rest, or when reversing the propellers, only the primary motors B and C in conjunction with rotor resistances are used. The propellers can be controlled independently—that is to say, one propeller can be run ahead and the second stopped or run astern if required—but under these conditions the secondary motors are cut out and the primary motors used as simple induction motors with wound slip ring rotors and rotor resistances. The utilisation of the direct-current excited synchronous machines as the secondary motors of the cascade system enables the alternator set to be operated at unity power factor, so that the size and weight of the alternator may be reduced to a minimum.—*May 4th*, 1925.

MEASURING AND TESTING INSTRUMENTS.

233,205. July 31st, 1924.—HARDNESS TESTING INSTRUMENTS, A. L. Haas, India Store Depôt, Belvedere-road, Lambeth, London, S.E. 1.

This instrument is of the impact type. The casing is telescopic and can be locked in the open or closed positions by means of a bayonet joint. It is shown closed. At the top there is a spirit level A and at the bottom the test ball B fixed in a flexible

diaphragm. The blow is provided by means of a falling ball C, which is held suspended by means of a garter spring D. When this spring is squeezed into a circular form the ball is free to fall.

Nº 233,205

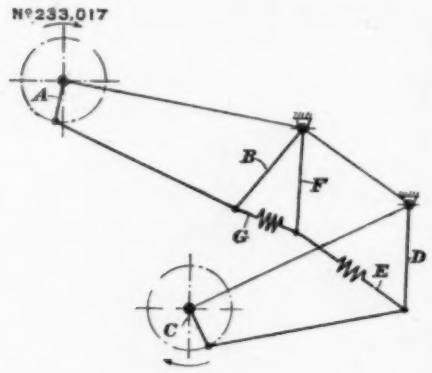
An alternative arrangement with the test ball fixed in the falling weight is included in the specification.—*May 7th*, 1925.

LOCOMOTIVES.

233,017. January 25th, 1924.—A CRANK DRIVE FOR ELECTRIC LOCOMOTIVES, Sir P. Dawson, Maybourne, Lawrie Park, Sydenham, London, S.E. 26; and Dr. E. Seefehlner, 17, Peter Jordanstrasse, Vienna XIX/1, Austria.

This invention aims at reducing the effect of vibrations between the motor and driving wheels of electric locomotives in which the power is transmitted through linkage. On the motor spindle there is a crank A which works the rocking lever

Nº 233,017



B through a coupling rod. The driving axle C has a crank which is connected with another rocking lever D. The two rocking levers are coupled together by a parallelogram of links E F, while F and B are joined by another link G. The links E and G have springs interposed in their lengths, as indicated, to absorb vibrations. Several modifications of the linkage are included in the specification.—*April 27th*, 1925.

MACHINE TOOLS AND SHOP APPLIANCES.

233,207. August 6th, 1924.—A TOOL FOR SCREWING UP NUTS, Abdulla and Co., Ltd., and O. Legg, 49, Wells-street, Oxford-street, London, W. 1.

This tool is intended for screwing up nuts by means of mechanical power. A box spanner is fitted on the cylindrical lower extension of the cone clutch A, which is driven through the bevel

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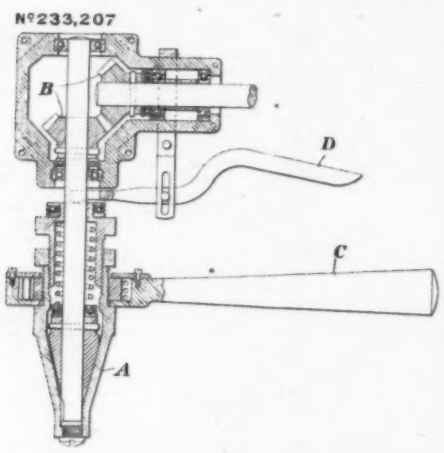

gearing B from any convenient source of power. The spanner is put on the nut and the nut is screwed home until the cone clutch slips, when an extra tightening can be given by the hand ratchet lever C. By pulling up the lever D the cone clutch is disengaged and the spanner is stopped without the motor being checked.—*May 7th*, 1925.

WELDING.

233,199. July 14th, 1924.—WELDING STRIPS FOR ARC WELDING, H. D. Morton, 248, West 105th-street, New York.

The inventor forms his welding electrodes with tapered socket joints as shown, so that fresh pieces may be added at the back

Nº 233,199

as the front end is fused away. The taper is slight in order to make hand pressure sufficient to give a good joint.—*May 7th*, 1925.

MISCELLANEOUS.

232,539. December 12th, 1923.—IMPROVEMENTS IN ELECTRIC JUNCTION-BOXES AND IN MEANS FOR BONDING METAL-COVERED CABLES THERETO, Francis Charles Raphael, of 35, Chase-green-avenue, Enfield, and W. T. Glover and Co., Ltd., of Trafford Park, Manchester.

This invention relates to that class of joint box in which the cables are introduced through the back plate, and has for its object to provide that the metallic covering of the cables shall be efficiently bonded to the box. The cables are clamped between a projection from the base of the box and a springy

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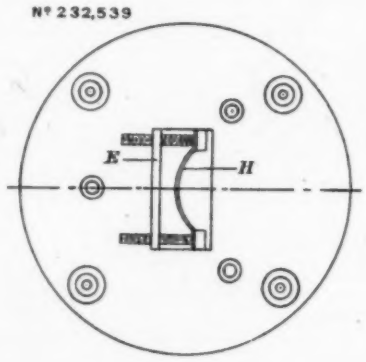
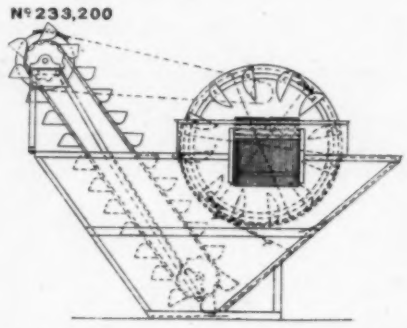


strip of metal, which is secured to the projection. An orifice may be made through the back plate by making slits round three sides of an oblong portion and by bending the portion E up at right angles to the back plate on the fourth side. A strip of springy metal H is arranged parallel to the upturned portion, and is secured by two screws passing through holes in the one and engaging threaded holes in the other, so that the cable can be placed between the two and by means of screws be squeezed between them.—*April 4th*, 1925.

233,200. July 15th, 1924.—A COKE WASHING MACHINE, J. Rigby, 35, Ardleigh-road, Hackney, N. 1.

This invention relates to an apparatus for separating coke from clinker, breeze and the like. It comprises a water tank divided into upper and lower communicating compartments, a rotary conveyor in the form of a bucket wheel rotating in the upper compartment and an endless chain bucket conveyor operating in the lower compartment. The upper compartment is also provided with a chute to discharge the material from the bucket wheel outside the tank, the chain conveyor being also arranged to discharge outside the tank. In operation the mixture to be

Nº 233,200



separated is fed into the upper compartment on to a slotted plate beneath the bucket wheel. The heavier clinker falls into the lower compartment, while the coke floats and is picked up by the bucket wheel and discharged on to the chute. The clinker is removed from the lower compartment by the chain conveyor and discharged. The churning of the water by the bucket wheel assists in the flotation of the coke, but if the coke is of such a nature that it does not float, clay may be fed into the upper compartment and cutters attached to the bucket wheel churn up the clay, increasing the density of the water in the apparatus and causing the coke to float. The illustration is self-explanatory.—*May 7th*, 1925.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, June 8th, Sir James Crichton-Browne, treasurer and vice-president, in the chair. Dr. Arthur Compton-Rickett, Maurice Alfred Nathan, Theophilus Caldwell Sandeman and T. Carlton Sutton were elected members. The secretary reported the deaths of Professors Albin Haller and Wilhelm Koerner, honorary members of the Institution, and resolutions of condolence with the families were passed. In connection with the celebration of the centenary of Faraday's discovery of benzene, Prince Ginori-Conti, Professors Gabriel Emile Bertrand, Ernest Julius Cohen, James Flack Norris, Joji Sakurai and Frederic Swarts were elected honorary members. The benzene centenary will be celebrated by an extra Friday evening discourse this evening—June 12th—which will be delivered by Sir William Pope on "Faraday as a Chemist," and on Tuesday, June 16th, the anniversary of the discovery, by a reception of delegates at 11 a.m. by the President, the Duke of Northumberland, when diplomas of honorary membership will be presented, and short addresses delivered. A banquet will be held in the evening in the Hall of the Goldsmiths' Company.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, S.W. 1. Papers:—"On Mass and Energy," by Dr. G. Temple; and "The Characteristic Curves of Liquid Jets," by Messrs. E. Tyler and E. G. Richardson. The following demonstrations will also be given:—"Some Experiments to Illustrate the Application of the Shakespeare Katharometer to Physical Research," by Dr. H. L. Daynes; and "Some Simple Apparatus for the Estimation of Carbon Dioxide," by Dr. Ezer. 5 p.m.

ROYAL INSTITUTION.—21, Albemarle-street, London, W. 1. Discourse, "Faraday as a Chemist," by Sir William Pope. 9 p.m.

TUESDAY TO THURSDAY, JUNE 16TH TO 18TH.

INSTITUTION OF MINING ENGINEERS.—Eighty-third general meeting at Cardiff. For programme see page 608.

WEDNESDAY, JUNE 17TH.

INSTITUTION OF CIVIL ENGINEERS.—In the Institution's Building, Great George-street, Westminster, S.W. 1. Conversazione. 8 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, London, S.W. Papers: (1) "Report on the Phenological Observations in the British Isles from December, 1923, to November, 1924," by Messrs. J. E. Clark, I. D. Margary, and R. Marshall; (2) "Measurements of the Amount of Ozone in the Upper Atmosphere," by Mr. D. N. Harrison and Dr. G. M. B. Dobson; and (3) "Meteorological Periodicities of the Order of a Few Years, and their Local Investigation: with Special Reference to the Term of 5.1 Years in Britain," by Mr. Joseph Baxendell. 5 p.m.

THURSDAY, JUNE 18TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Some African Problems," by the Hon. W. Ormsby-Gore. 4.30 p.m.

THURSDAY TO SATURDAY, JUNE 18TH TO 20TH.

NEWCOMEN SOCIETY.—Summer meeting at Gloucester.

SATURDAY, JUNE 20TH.

THE INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the works of Ley's Malleable Castings Company, Limited, Derby. 2.30 p.m. The party will leave Manchester (Central) at 12.20 p.m.

THURSDAY, JULY 2ND.

INSTITUTION OF ELECTRICAL ENGINEERS.—At the Natural History Museum, Cromwell-road, London, S.W. Conversazione. 8.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that Mr. S. Nichols, for many years on the staff of the Birmingham office of the British Thomson-Houston Company, Ltd., has been appointed manager of that company's office at Middlesbrough.

MR. F. L. WARREN, consulting engineer and naval architect, notifies us that he has changed his address from No. 155 to No. 139, Fenchurch-street, London, E.C. 3. His new telephone number is Avenue 5240.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., of Egyptian House, 170, Piccadilly, London, W. 1, asks us to announce that it has opened an office and service depôt at 2, Harrington-street, Sydney, Australia.

MR. W. A. BRISTOW, M.I.E.E., M.I.A.E., F.R.A.E.S., informs us that he has vacated his offices from 104, High Holborn, London, W.C. 1, to 39, Grosvenor-place, Westminster, S.W. 1. Telegrams, "Sinecos, London;" telephone number, Franklin 6540.

S. AWAD AND CO. ask us to state that, owing to the expansion of their business in Palestine, their office at Rue Memphis, Port Said, Egypt, has been closed, and that all business connected therewith has been transferred to the firm's Jerusalem branch, Mamillah-road (P.O.B. 86), which henceforth will be its head office.

THE ironworks at Derby which originally belonged to Eastwood, Swingler and Co. have been purchased by Thos. W. Ward, Ltd., of Sheffield, for the purpose of dismantlement. The business was taken over by the receivers in April last. The firm of Eastwood, Swingler and Co., Ltd., was one of the oldest in Derby, having been founded about 1850.

ALFRED HERBERT, Ltd., has terminated its agreement with the J. M. Carpenter Tap and Die Company, Pawtucket, R.I., U.S.A., and has entered into an agreement with the Morse Twist Drill and Machine Company. The Coventry firm will, in future, be agent for all Morse carbon steel tools and sole agents in Great Britain and Ireland for all Morse screwing tackle.

THE INSTITUTION OF STRUCTURAL ENGINEERS.—The recent ballot for the election of officers and Council of the Institution of Structural Engineers for the session 1925–26 gives the new constitution of the Council as follows:—President: Sir Charles T. Ruthen; vice-presidents: H. J. Deane, M. Inst. C.E., M.I. Mech. E., Dr. Oscar Faber, M. Inst. C.E, J. Mitchell Moncrieff, M. Inst. C.E., R. H. H. Stanger, A.M. Inst. C.E.; past presidents (*ex-officio* members): Major James Petrie, E. Fiander Etchells; hon. secretary, H. Kempton Dyson; hon. editor of publications, Ewart S. Andrews; hon. librarian, R. W. Vawdrey; hon. curator, A. C. Davis, M. Inst. C.E.I.; members of Council (retiring 1928): S. Bylander, Professor F. C. Lea, E. C. P. Monson, H. D. Searles-Wood; (retiring 1927): W. A. Green, G. B. R. Pimm, A.M. Inst. C.E.; (retiring 1926): Professor Henry Adams, M. Inst. C.E., H. John Collins, Adam Hunter, M. Inst. C.E., J. O'Hanlon Hughes, J. T. Saunders, Thos. Wallis.